The FOUNDRY
January 1918
CLEVELAND, OHIO.
Vol. 46, No. 1 Whole No. 305

How Cores Are Used to Cut Molding Costs

An Interesting Account of How a St. Louis Manufacturer Effected Large Savings in Molding by a More Extensive Use of Cores

TO REDUCE costs and to simplify molding operations, progressive foundrymen have found it advantageous to make a thorough study of the possibilities of using cores more extensively. In some cases, where intricate patterns are to be cast, the judicious employment of cores results in a net saving in molding expense. More often, the saving is indirect in that the cores permit the work to be handled in such a manner that better castings are produced, with fewer losses and rejections.

It should be borne in mind in any consideration of this problem that there is a point, sometimes soon reached, where the saving in molding time resulting from the use of cores is overbalanced by the increased coreroom expense. This may be particularly true where the cores are complicated and, therefore, difficult to make and easily broken. On the other hand, large savings may be realized through the skillful use of cores in green-sand molding operations. Each pattern must be considered on its individual merits. In the case of the automobile starting-motor job, which is shown in the accompanying illustrations, the use of cores brought about material savings, and also made it possible to turn out better castings. This achievement is the result of the ingenuity of J. P. Pero, superintendent, Missouri Malleable Iron Co., East St. Louis, Ill., in whose plant the work under consideration is being executed.

The finished casting in shown lying on its side at the right in Fig. 4. The casting forms the entire frame and commutator cage for an automobile starting-motor. It is approximately 11 inches in length and 6 inches in diameter. The casting weighs about 11 pounds.

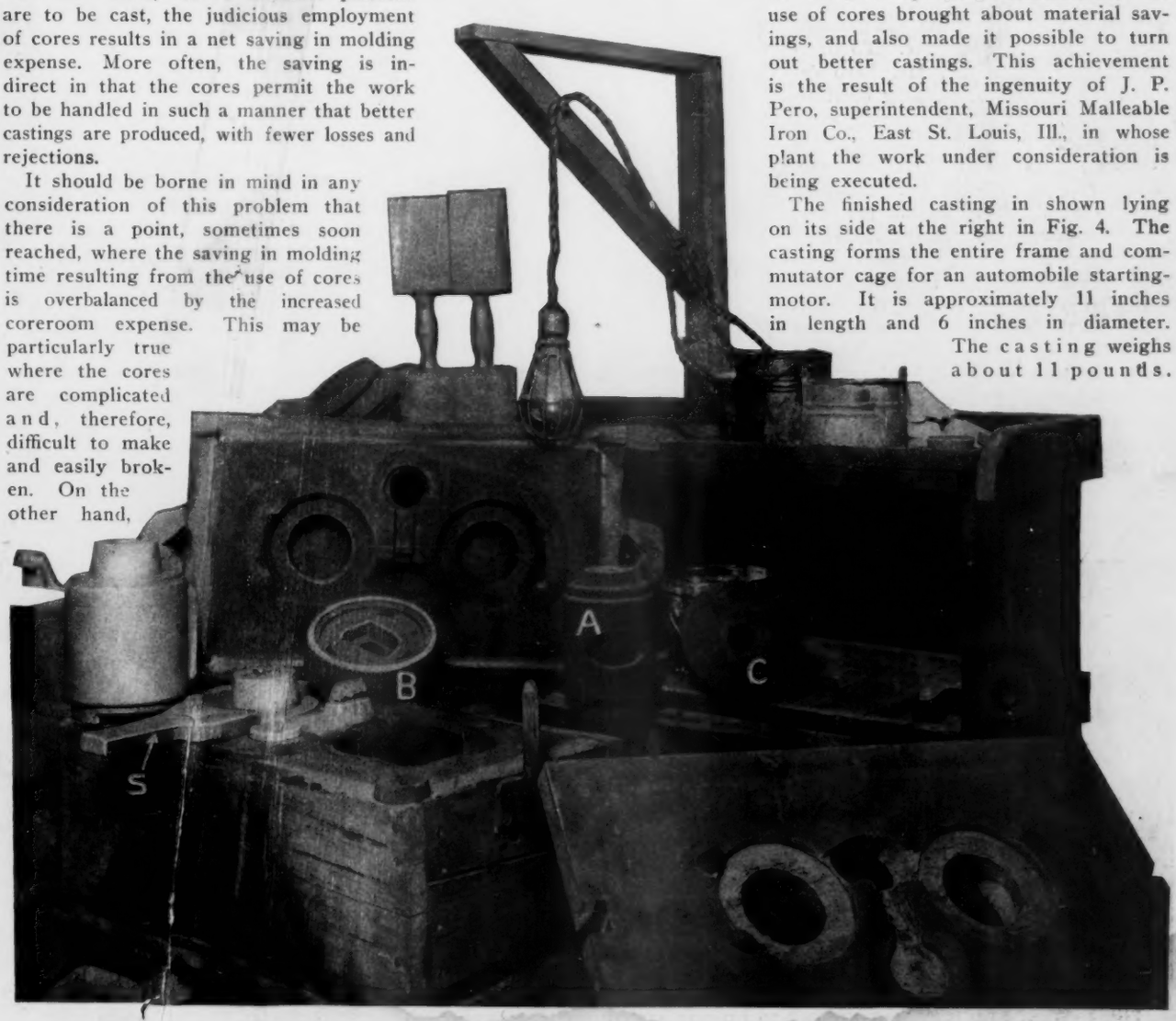


FIG. 1—MOLD FOR AUTOMOBILE STARTING-MOTOR FRAME SHOWING EXTENSIVE USE OF CORES

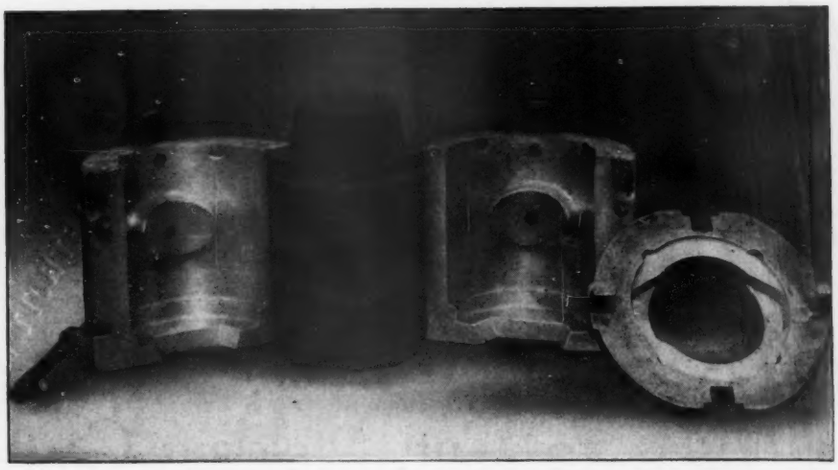


FIG. 2—BARREL CORE AND COREBOX FOR AUTOMOBILE STARTING-MOTOR

Originally it was molded on its side entirely in green sand, using a split pattern and a single center-core. This method of production was unsatisfactory not only because the output was relatively low and the piece rate correspondingly high, but also because it was difficult to produce a perfect casting free from disagreeable fins along the parting line. To overcome these difficulties, Mr. Pero devised the method of molding illustrated in Figs. 1 and 4, using the dry-sand cores shown in Figs. 2 and 3. As a result, one relatively unskilled man, working at an ordinary bench, is now able to turn out 70 molds per day, each containing two castings. Although the price has been reduced to 10 cents per mold by this method, a very satisfactory figure from the standpoint of the company, the molder is still able to earn unusually good wages without undue exertion.

There are three cores in each mold, not counting the small skim-gate core. They include the central or barrel core, as shown in Fig. 2, the circular cage core shown at the right in Fig. 3, and the plate or cover core shown at left in the same illustration. These cores are indicated respectively, *A*, *B* and *C*, in Fig. 1. This illustration also shows the drag half of the mold with one of the barrel cores in the proper position.

The barrel core forms the interior of the casting. It is about 12 inches long and 5 inches in diameter. It is made in a white-metal core box, the details of which are shown in Fig. 2. As this illustration indicates, the box is split longitudinally. It also is provided with a cover piece shown at the right which forms the tapered end-print on the core. It was necessary to split the box longitudinally in order to make the recesses in the side of the core that form the pole pieces of the motor. These cores are made at a bench by a boy who turns out about 350 finished cores per day.

A rosin and sand mixture is employed for the barrel cores. Thirty parts of sand to one part rosin are used. The sand consists of 30 per cent gangway sweepings, 20 per cent new molding sand and 50 per cent new silica sand. This forms a strong, economical, satisfactory core that is easily knocked out of the casting.

The core box for the commutator-cage core is shown at the center in Fig. 3. It consists of two parts. This core box also is made of white metal and is carefully finished all over. A boy working at a bench turns out 450 cores per day without difficulty. A straight oil and silica-sand mixture is used for these cores. 60 parts sand to one part oil.

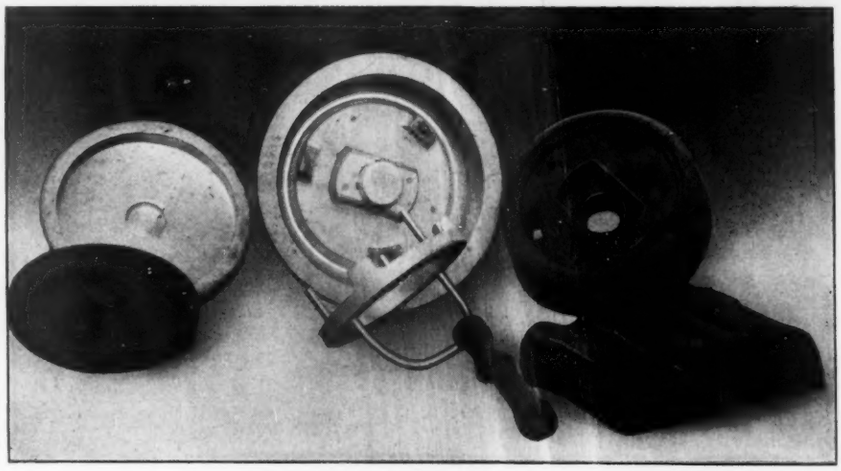


FIG. 3—PLATE CORE, CAGE CORE AND DRYSAND CORE DRYER

The core box for the plate or cover core which is exceedingly simple is shown at the left in Fig. 3. A mixture of 80 parts sand to one part oil is employed for these covers and a boy makes about 750 cores per day.

The general arrangement of the molder's bench is shown in Fig. 1. Simple, but adequate equipment is provided. White-metal patterns are employed. The bottom-board, properly recessed to receive the patterns, is shown in the lower right-hand corner of Fig. 1. The first step in making the mold is illustrated in Fig. 4. It consists in arranging the patterns on the bottom board and setting the cage and cover cores in place on top of the patterns. The drag

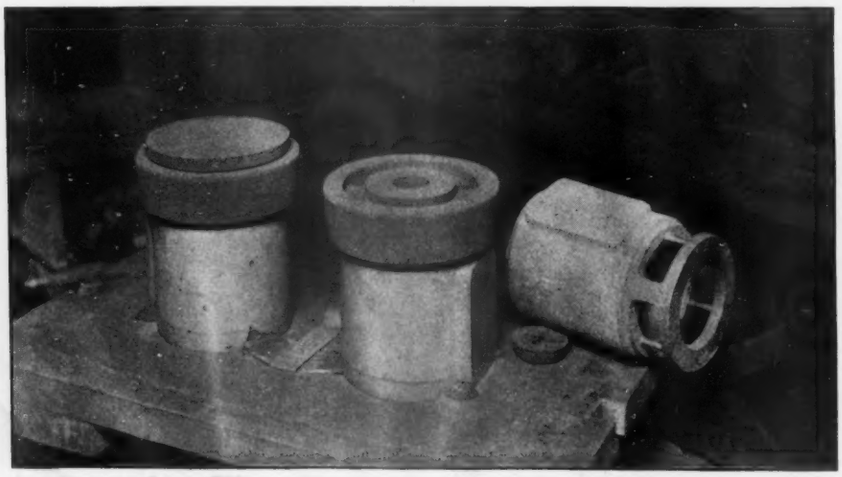


FIG. 4—FIRST STAGE IN MAKING THE MOLD FOR AUTOMOBILE STARTING-MOTOR FRAME SHOWING USE OF CAGE AND PLATE CORES

✓ 605 FG3
V.46

FIG. 5—CORE-SAND MIXING DEPARTMENT

is next set in place, filled with sand and rammed. After the drag has been rolled over it appears as shown in Fig. 1. This illustration is a view of one of the patterns drawn from the sand. The other pattern is ready to be drawn. The molder uses the steady rest, *S*, to assist in drawing the pattern without tearing the mold. The general arrangement of the cope mold which houses the upper portion of the cores also is shown in Fig. 1.

To reap the full benefit from the use of cores in jobs such as the one just described, it is necessary to have a completely equipped, modern coreroom. The general arrangement of the extensive coreroom of the Missouri Malleable Iron Co. is shown in Fig. 6.

Arrangement of Benches

The benches in the core department are arranged in parallel rows with space between for the tracks over which the oven cars are run. Shelf-type cars, shown in the background in Fig. 6, are employed. The cars are run out from the ovens to convenient points between the benches where they are loaded. It is not necessary, therefore, for the coremakers to take any steps in loading the cars. As each plate of cores is finished, the workman simply has to turn around to place it on the oven car. By means of a transfer car, installed in front of the battery of ovens, any carload of cores may be run into any oven for baking.

The ovens, which are coal-fired, are arranged along one side of the shop, as shown in the background in Fig. 6.

FIG. 6—GENERAL ARRANGEMENT OF COREROOM SHOWING SMOKE EXHAUST HOODS

Eleven car ovens have been provided together with eight 5-drawer shelf ovens.

The fumes which frequently are obnoxious in corerooms are removed in the Missouri Malleable Iron Co.'s plant by means of the continuous exhaust hoods installed over the transfer track in front of the ovens. Each individual hood is connected with a high stack giving sufficient natural draft to remove the gases effectually. The entire core department occupies a room 175 feet long and 60 feet wide.

The sand-mixing room, Fig. 5, is located adjacent to the coreroom proper. It is equipped with a paddle-type mixer furnished by the Standard Sand & Machine Co., Cleveland. A gyratory riddle, manufactured by the Great Western Mfg. Co., Leavenworth, Kans., also is provided. It is employed for the preliminary sifting of the silica sand which is stored at the rear of the room. The mixed batches of core sand are dumped from the paddle mixer into boxes mounted on casters, as shown in Fig. 5. The prepared sand is distributed to the proper points in the coreroom by means of these boxes. The residue collected by the screen in the sand mixer is discharged into a wheelbarrow for final disposal.

Sand Core Dryers

The sand mixer is mounted on concrete pedestals so it may be conveniently discharge. It is charged by means of a simply arranged bucket elevator. With the apparatus shown in Fig. 5 it has been possible for two laborers to mix and deliver to the floors a carload of core sand in a day. In order to stimulate production in the sand-mixing department, the men are paid for their work on a piecework basis.

In place of ordinary metal core dryers, the Missouri Malleable Iron Co. uses sand dryers. They have proved exceptionally economical and satisfactory. One of these dryers is shown at the extreme right in Fig. 3. It consists of a plate of hard baked core sand in which impressions of the cores to be dried have been imprinted. A lead core is used for making these impressions at the time the dryers are rammed.

The dryers are made of pure silica sand with as strong an oil mixture as possible. Each dryer is treated to a double baking before it is used. For the first or primary baking, the oil is mixed with the sand in the proportion of one part oil to 80 parts sand. Then before the second or final baking the dryer is soaked in oil until it has absorbed all it will take up. An extremely hard, tough plate results and it is claimed these dryers last from three to four months in constant use. Their life is prolonged by occasionally swabbing them with oil and rebaking.

Determination of Moisture in Coke

An interesting series of experiments to determine a simple method for ascertaining the amount of moisture in coke has been concluded by A. J. Fieldner and W. A. Selvig, of the United States bureau of mines. In their report it is stated that moisture can be determined quickly and with adequate accuracy, within plus or minus 0.5 per cent, by simply heating to constant weight a large sample of lump coke in any convenient oven or stove, hot plate or steam coil, at a temperature of from 100 to 200 degrees Cent.

In making the tests reported upon, a sample of approximately 50 pounds of lump coke was crushed to pass a 1-inch mesh sieve and was thoroughly sprayed with water. It was then mixed for some time and allowed to stand several hours. The moist coke was then placed on sampling cloth, again mixed, coned and divided into four parts. Each quarter was placed in a tarred, galvanized iron pan, 22 x 26 inches and immediately weighed. The coke was spread to a depth of about 2 inches. One sample was placed in an air-drying oven and was dried to a constant weight at 30 to 35 degrees Cent., then pulverized and reduced to a 60-mesh laboratory sample. The other three samples were dried to constant weight on ordinary gas-heated hot plates at temperatures of 120, 150 and 200 degrees Cent., respectively. An air space of ¼ inch between the bottom of the pans and the hot plate was provided and the temperatures were determined by inserting thermometers in the bed of coke near the bottom of the pans. The samples dried at 120 degrees Cent. and the one dried at 200 degrees Cent. had 5.9 per cent moisture. These results were 0.2 per cent higher than that obtained with a sample that was air-dried before the moisture was determined by the standard laboratory method outlined. The small differences in results with the various portions were probably due to the unequal wetting rather than to the temperature of drying, and even the maximum difference is within the sampling error.

Results Summarized

In summarizing the results of these experiments, the investigations show that the influence of temperature, time, humidity of drying atmosphere and fineness of sample on the determination of moisture in coke may be varied over a considerable range without appreciably affecting the result. Oven temperatures ranging from 105 to 200 degrees Cent. produced a maximum variation in moisture of not exceeding 0.2 per cent. It was also ascertained that coke can be dried to constant weight without any gain in the weight taking place. The circulation of air dried by sulphuric acid, through the oven atmosphere, as specified by coal analysis, was found to be unnecessary, there being no measurable difference of results between circulating perfectly dry air through the oven and using in the oven the natural circulation of air from the room.

Changes in Sales Force of Sullivan Machinery Co.

Wallace T. Roberts, formerly sales manager of the Sullivan Machinery Co., Chicago, in lower Michigan, northern Ohio and northern Indiana, has been appointed district manager at Denver. Mr. Roberts succeeds Captain M. R. Blish, ordnance department, U. S. A., who has been been acting manager at Denver since last May. George W. Blackinton, manager at Denver until last May is captain commanding the third battalion, 353rd infantry regiment, Camp Funston, Kan. Joseph H. Brown, assistant manager of the New York office of the Sullivan company, has been appointed district manager at Chicago to succeed William P. J. Dinsmoor, who has resigned to engage in business at Denver.

Abell-Howe Co. Establishes Branch Offices

The Abell-Howe Co., 565 Washington boulevard, Chicago, has found it necessary, because of the growing demand for its lines of high speed chain, elevated trucks, electric cranes and hoists, to establish branch offices at 30 Church street, New York, in charge of J. R. Shays Jr.; at 5086 Jenkins arcade, Pittsburgh, in charge of C. W. Wheeler and Wayne Paulin, and at 803 Ford building, Detroit, in charge of H. G. Bates. The company also is represented, in connection with the sale of Howe trucks, at Boston by the Boston Steel & Mfg. Co., and in the Atlantic coast states, Pittsburgh and Cincinnati territory, by the Howe Scale Co. and the J. S. McCormick Co. In addition, it is represented in New England by the Watkins Engineering Supply Co., Boston, and in the northwest, by Frank J. Rose Co., Minneapolis, for the sale of American high speed chain.

Iron Oxide---Its Effect on Molding Sand

Tests on Iron Oxide by the Author Indicate That Percentages of Over 3.5 Per Cent in Sand Are Detrimental to the Bonding Qualities

By W R Bean

THE effect of the presence of iron oxide even in small amounts in molding sand is detrimental and militates against the best results in the production of small and medium weight castings, especially where clean metal and good surface finish are of prime importance. Nearly all molding sands, as taken from the earth, contain iron oxide. Obviously that sand possessing the smallest amount is the best, other elements being equal. This statement may seem a broad one, but it is based on three separate experiences in which careful analysis and study of the conditions proved iron oxide to be the source of the trouble experienced.

In the production of castings requiring a large number of cores, the greater part of which could not be separated from the molding sand in taking out the castings, the expense of maintaining the sand in proper condition by the addition of new sand was found to be unusually high. A search was made for a suitable binding material, which resulted in the application of the fine dust deposited at the dust arrester in the hard iron cleaning room. When mixed alone this dust possessed unusual bonding qualities, and for this reason permission was secured to add it to the sand pile on a machine floor.

It was very soon demonstrated that the addition of this material was not accomplishing the desired results. On the other hand, conditions were made much worse, as evidenced in sand washing, where the metal flowed over the mold surface and in "drops" where any amount of sand was left suspended. The trouble was not at this time attributed directly to the presence of iron oxide, but later experiences proved this to have been the cause.

While endeavoring to lower the cost of sand maintenance, a molding sand was found, which in the fresh or new state seemed to possess unusual bonding qualities. Several carloads were ordered and put into use on two machine floors requiring a large amount of sand. The quantity added at the start was the same as that previously used of a sand which met the requirements but entailed a heavy expense. The new sand gave approximately the same results as that from the dust collectors, except that it burned so hard in the pockets of castings that it was practically impossible to remove by the ordinary methods of cleaning.

To determine what chemical elements might be present in this sand which would account for this result, complete chemical analysis was made. Unfortunately I have not the exact figures, and although it is now several years since the occurrence, I clearly recollect that the amount of iron oxide in the new sand was slightly in excess of 5 per cent. The use of that sand was immediately discontinued and the original sand was again employed. In a short time the trouble disappeared.

In 1913, while making an investigation of a continuous mechanical foundry plant having all of the latest devices for preparing and handling molding sand, I found that a great deal of trouble was being experienced as a result of the sand forming in small, hard lumps which would not disintegrate in any of the screening or sand rolling units of the equipment. Investigation of the source of the sand supply and of the disposal of sand from the dust collector showed that the new sand was of fair quality, but that the sand from the dust collector was being returned to the molding sand conveying and preparing units.

Analyses made by Booth, Garrett & Blair showed that the new molding sand in stock contained 3.5 per cent iron oxide. The lumps of sand formed in the sand handling units contained 8.5 per cent iron oxide, and material from the dust collectors contained 6.61 per cent iron oxide, with 4 per cent magnetic iron in very small particles. My conclusions were that the source of trouble was in the addition of this fine dust from the dust collectors. That these conclusions were correct was proved by the fact that in a short time after the addition of this material was discontinued and new sand added, the lumping of the sand disappeared.

The action which takes place is a combination of this oxide material with the silica contained in the sand to form a silicate of iron, temperatures produced by contact of hot metal with the mold surface being sufficiently high to cause the combination.

From my experience in the use of molding sand in the malleable industry, I feel that so far as the surface finish of castings is involved, the elements in the sand which have a bearing on the results may be divided into two classes —those which burn out and cause roughness of the casting surface as a result of penetration of the metal into the mold surface, and those which combine with the iron to leave a depression in the casting surface when these are subjected to a severe cleaning such as sandblasting. Iron oxide, I believe, is the principle element in this class.

A series of tests recently made with various facing mixtures prepared by passing the material through riddles or sand mullers or mixers affords further proof of the accuracy of the statement made regarding the effect of the presence of iron oxide in molding sand, the best surface finish being obtained by the use of a facing of new fine molding sand put through a sand mixer or muller without the addition of sea coal facing or any other element.

Castings from molds faced with a mixture containing one part medium sea coal facing, six parts new fine molding sand and 14 parts of fine dust from the dust collector, show both depressions and projections on the surface after sand-blasting. The mixture is tempered with a wash of one part glucor and four parts water, which is used to bind the facing. It appears that the projections on the surface of the castings result from burning out the fusible elements or materials and that the depressions result from the formation of more iron oxide than is present in the sand at the time of casting, according to the equation,

$$2\,Fe_2O_3 + 2Fe = 6\,FeO,$$

or from other chemical combinations.

The irregularities in the surface of the castings are present whether the sand is mixed by hand and passed through a fine riddle or mixed by passing through a sand muller or mixer, but the latter treatment of the facing gives a much better appearing casting surface.

(*Concluded on Page* 34)

Presented at the annual meeting of the American Foundrymen's association. The author is with the Naugatuck Malleable Iron Works, Naugatuck, Conn.

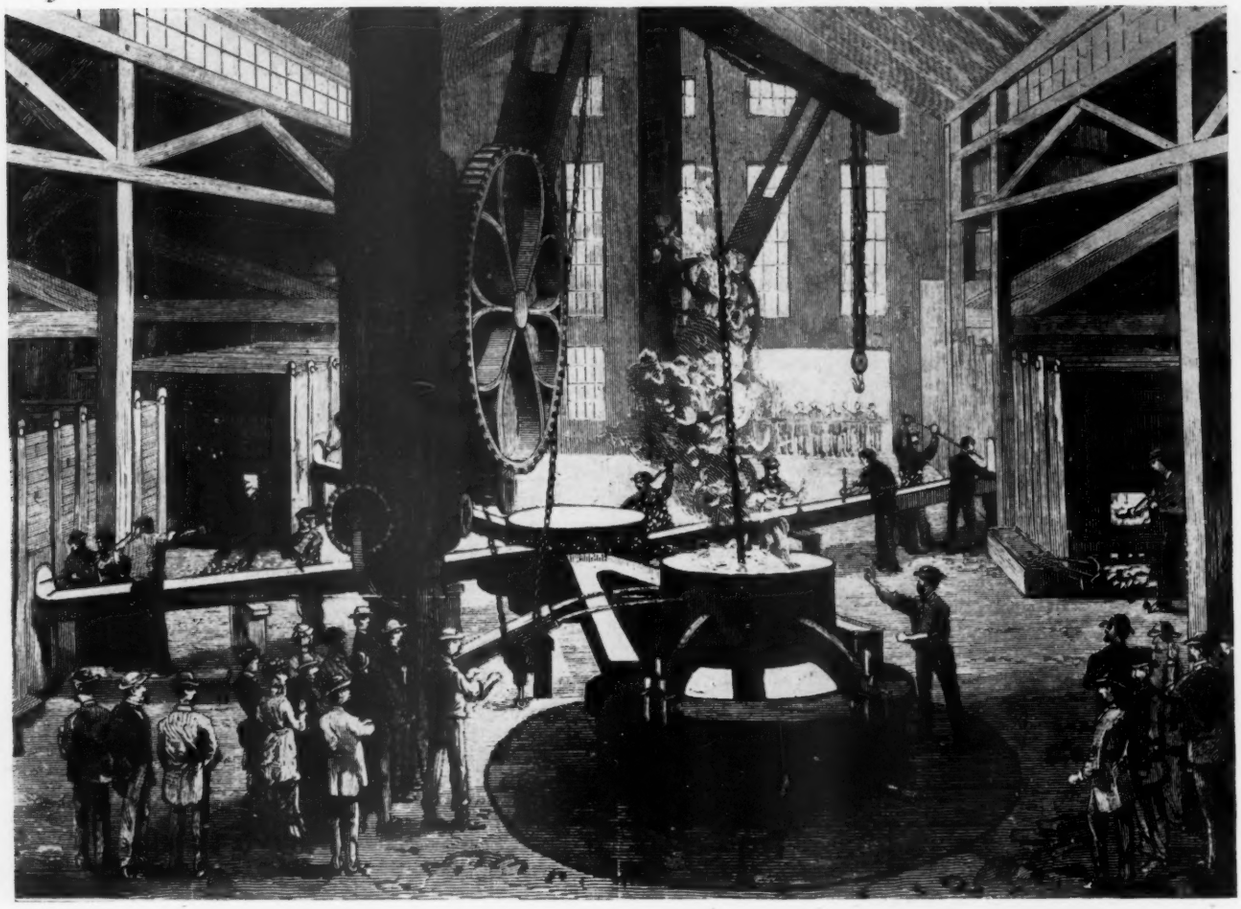


FIG. 1—POURING LARGE GUN CASTING AT PLANT OF SOUTH BOSTON IRON WORKS IN 1884

Casting Large Guns in the Early Eighties

By Job Goostray

NO PERIOD in the development of large guns is more interesting from the standpoint of the foundryman than the latter part of the nineteenth century. The dimensions of castings were gradually increasing, and the difficulties involved in preparing the mold, pouring the metal and controlling the cooling, challenged the best knowledge and practice of the industry.

In October, 1880, the South Boston Iron Works received a contract from the United States government to make four large guns. To accommodate this work, a 24-foot pit in the foundry was deepened to about 40 feet. A special flask and core arbors were made and two massive lathes, approximately 90 feet long, were installed in a new building erected to house them. It was not until March, 1884, that the equipment was in place and ready for molding the first gun. James Wood foreman of the ordnance casting department, had charge of the work and the writer was his assistant.

We started to mold the first of the four guns on March 12, 1884, and it was cast March 28. The mold was approximately 33 feet long and about 33 inches in diameter. It was cast successfully by what is known as the Rodman method of casting, which provided for the circulation of water in the interior of the core arbor, as shown in Fig. 4. After the water had run for about 18 hours, the core arbor was removed and a pipe inserted in the bore of the casting for the purpose of cooling it. This was kept up for about 90 hours. The temperature of the water, taken at different intervals throughout the cooling, ranged from 40 degrees on entering up to 168 degrees on leaving the casting. After it was sufficiently cooled, the casting was lifted from the pit by two cranes, cleaned and placed in the machine shop for finishing. This gun was then taken to the Watertown arsenal to be wound with wire, it being known as a 10-inch wire-wound rifle. When finished, it weighed 28 tons and was 25 feet long.

Preparations were then made for molding a 12-inch breech-loading rifle to be cast breech *up*. This casting was 38½ feet long, necessitating a flask 40½ feet long, 27 inches in diameter at the bottom and 57 inches at the top. The estimated weight was 95 tons. The gun was cast May 6 and the arbor was left in the casting until May 8. The metal was cooled by two water pipes, one extending almost to the bottom and one about 15 feet down, thus allowing the heaviest stream of water to pass in the heaviest part of the casting. The water was kept running continuously from May 6 to May 13, except while the arbor was being removed. On May 13 the flask and sand were removed from the casting. A contract was made with a building mover to take the gun out of the pit and place it in the lathe for the sum of $550. The contractor worked five weeks before he succeeded in lifting the casting from the pit. The finished gun was 30 feet long and weighed 54 tons. The third gun, a 12-inch breech-

loading rifle, was the largest that had been cast in the United States up to that time. It was cast breech *down* and required approximately 120 tons of metal for the rough casting. The gun was 57 inches in diameter at the bottom and 43 inches at the top. It was cast about 12:30 p. m., July 9, 1884, and it required 28 minutes to pour the metal. The mold was made in 10 sections. Starting with the trunnion part, the sections were rammed below and above from this one. The core was made up on a special car, the core arbor having a bearing in the center to prevent it from sagging. The arbor was then wrapped with ½-inch sisal rope, the latter being thoroughly dried and wound on the arbor under great tension to avoid any looseness after the core was dried. When the core was ready for the mold, the car with the core upon it was placed alongside the molding pit. The core was then lifted by both ends and by a collar clamped at the center to prevent sagging. The core had to be raised 45 feet before entering the mold. While the core was held in a vertical position over the mold, the collar clamp was removed and the surface repaired and dried. The core was then lowered to its place in the mold.

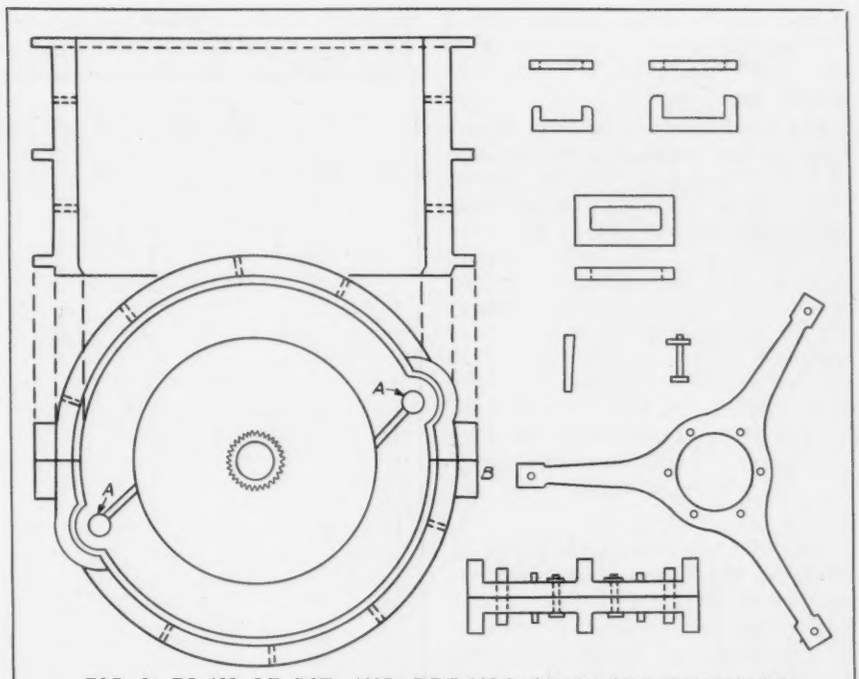


FIG. 3—PLAN OF PIT AND DETAILS OF FLASK FIXTURES

The drawing at the left shows the plan of the casting pit; A A represent runners 3 inches in diameter. Twenty inlets connected each of the vertical runners with the mold. The small figures at the right are clamps, pins and links used to secure the flask. The three-armed tripod used to adjust the position of the core in the mold is also shown at the right.

Failure of Flask Ruins Casting

About an hour after being cast the flask gave way and all of the iron went to the bottom of the pit. The failure of the flask caused a tremendous outrush of gases that hurled the pit covers to the roof 50 feet above, setting fire to the building. Fortunately no one was near the casting pit at the time. The water running into the pit created a seething, boiling mass for many hours after the explosion.

On July 14, Mr. Wood and the writer went down into the pit to investigate the failure of the flask. It appeared that No. 3 section of the flask had given way. The remnants of the flask and the sand were taken out. In trying to remove the arbor, it pulled apart about 12 feet from the end. Holes were drilled and tapped in the mass of iron in the pit and heavy screws were inserted. These made it possible to hoist the

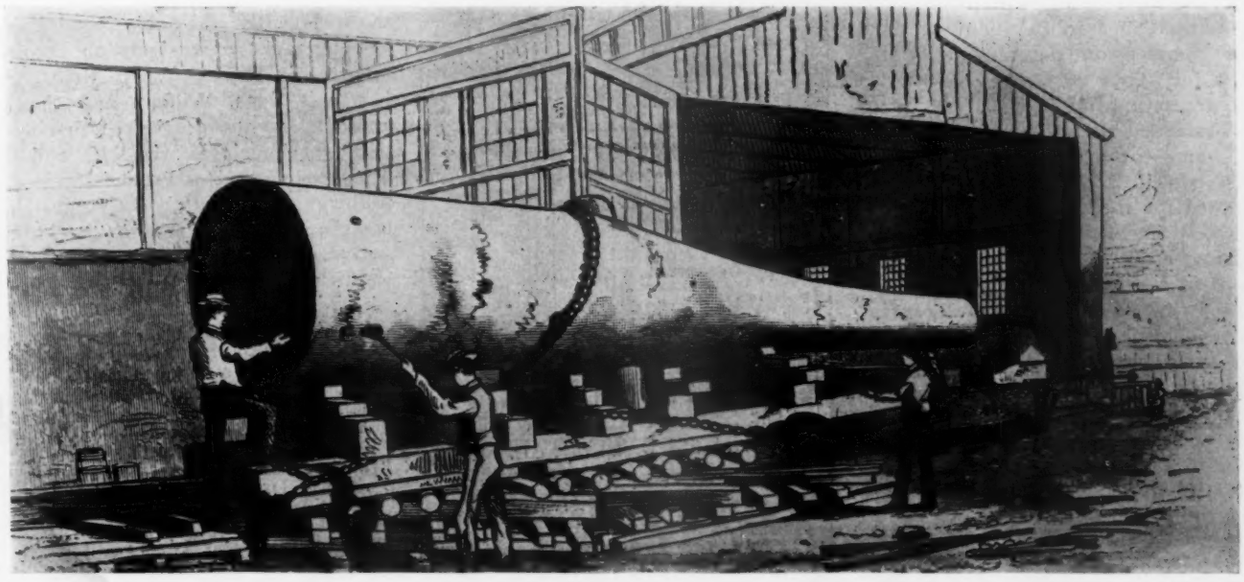


FIG. 2—ONE OF THE GUNS WAS MOVED ON ROLLERS BY WINDLASS AND BLOCK AND TACKLE

The casting, cleaning and machining of large guns in shops not specially designed for that work involved many difficulties. Special molding pits had to be constructed and furnaces had to be connected with a central metal receptacle to enable simultaneous tapping. In the absence of cranes or cars of sufficient capacity to handle the gun casting, it was necessary on one occasion to hire a house mover to move the casting from the molding pit to the lathes. This operation is pictured above.

iron by two hydraulic cylinders placed at the outside of the pit. After a few years the iron was sold and broken up.

The accident caused a delay in carrying on the work and it was not until Oct. 1 that work on the contract was resumed. On Oct. 6 we commenced to mold a gun of the hoop and tube type. This casting, about 38½ feet long, was molded and cooled by the same method employed in making the other guns. The metal was tapped at 12:30 p. m., Oct. 31, and 25 minutes elapsed while the mold was being filled. The furnaces had been charged 14 hours previous to the time of pouring. In all, approximately 76 tons of iron were required for the casting.

Some difficulty was experienced in removing the core arbor. We attempted to remove it 24 hours after casting, but were unable to start it. Mr. Wood adopted the plan of taking it out by expansion. We stayed all night and the following morning were successful in removing it. We found that iron had worked its way into the grooves of the arbor thus causing the difficulty. A slow stream of water was kept running in the interior of the bore until Nov. 6, when the water was shut off and the flask and sand removed.

Second Attempt Proves Futile

On Nov. 11 we again attempted to mold a 12-inch breech-loading rifle similar to that which caused trouble in July. The furnace was started at 9 p. m., Dec. 22, and was tapped at 11:15 a. m. the following day. The mold was filled in 35 minutes. Sand was rammed on the outside of the flask for about 20 feet to counteract the pressure from inside. The arbor was removed the following day, about 24 hours after casting. The gun was cooled according to the plan adopted for the castings already mentioned. During the process of machining, a small crack was discovered in the interior of the gun which caused its rejection by the government officials. It was thought that too rapid cooling caused the defect. Another gun, cast in the following August, proved to be defective. Failure in this instance was caused by the washing away of the coating of the core arbor, allowing the iron to flow into the interior of the arbor. The writer was not employed on this gun and therefore is not familiar with the details.

Work was commenced on another gun of this type, March 1, 1886. The fires were started on Sunday night, April 4, and the mold was poured the next day. The mold was filled in 33 minutes. The core arbor was not removed until April 9. A small stream of water was directed into the casting for four days, the cooling proceeding very slowly. This was a very successful casting.

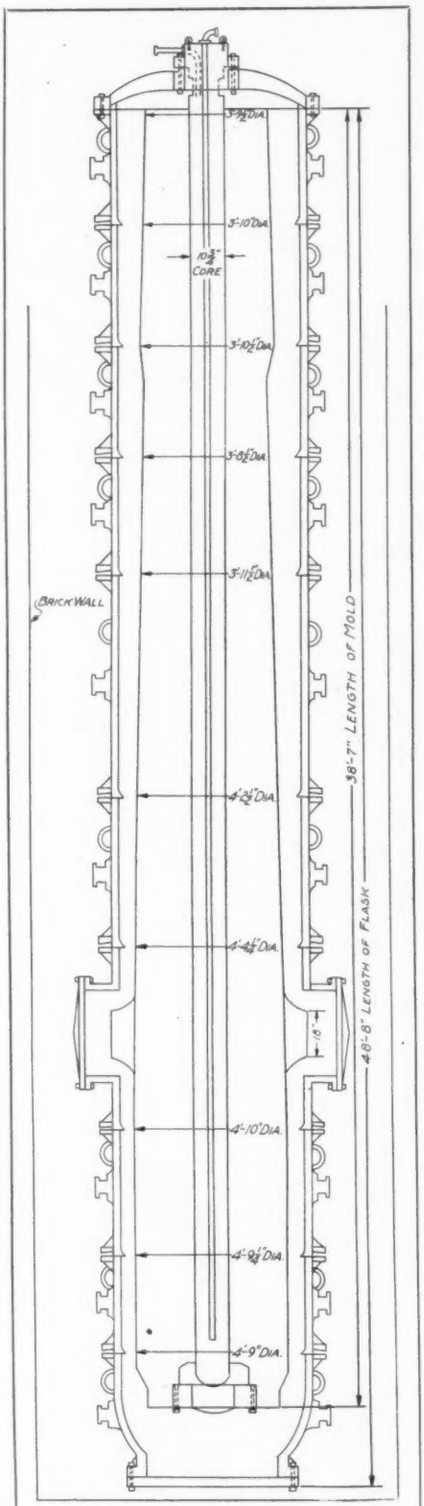


FIG. 4—ARRANGEMENT OF FLASK

This shows the arrangement of a flask used in molding a large gun with breech down. The sections of the flask were held together by clamps, pins and links shown in Fig. 3. The method of supporting the core is clearly shown.

After making the four castings mentioned, 30 breech-loading mortar bodies were made. They averaged about 18 feet in length, 34 inches in diameter and 23 tons in weight.

An 80-year Old Foundry Changes Hands

Founded in 1837, a foundry and machine shop in Brownsville, Pa., has been sold by J. Herbertson's Sons to Ira E. Stevens and William P. Walker, Pittsburgh, who took over the property on Dec. 15. This concern, the oldest in Brownsville, was established by John Herbertson, a molder, who came to New York from Scotland 100 years ago. After working at his trade in Marietta, O., Mr. Herbertson returned to Pittsburgh and subsequently was employed by John Snowden of Brownsville, in whose foundry he went to work.

Mr. Snowden was given the contract to build an iron bridge across Dunlap's creek, connecting Brownsville and Bridgeport, now South Brownsville, and John Herbertson was charged with the designing and construction of this bridge, said to have been the first one erected by the government in America.

Mr. Herbertson started in business for himself in 1837 in Brownsville. In 1850 the Herbertson engines were installed in many of the steamboats on the Monongahela, Ohio and Mississippi rivers. During the succeeding years mining machinery and pit cars were made with great success and more recently the old foundry has been engaged extensively on automobile repair work. When John Herbertson's Sons, William and George, grew to manhood, their father took them into business with him and the firm became J. Herbertson's Sons and following the death of George Herbertson several years ago, the latter's son, James R., too his father's place in the firm.

Booth-Hall Electric Furnace Installations

The West Michigan Steel Foundry Co., Muskegon, Mich., will install a 3-ton electric steel furnace built by the Booth-Hall Co., Chicago. This furnace will have a capacity for producing 30 tons of steel in 24 hours and is of the same size as the furnace that will be placed in operation by the Midland Electric Steel Co., Terre Haute, Ind., early in November. The Duriron Castings Co., Dayton, O., also will install a ¾-ton Booth-Hall furnace for the production of this high silicon metal.

Harnessing the Electric Furnace to the Foundry

The Astounding Progress and Knowledge Which Has Come to Feature This Electrical Unit is Making Even the Most Skeptical Foundrymen Realize Its Merit

By Douglas Walker

SENTIMENT in the steel foundry industry toward the electric process has undergone a radical change. The period of skepticism and criticism, of experiment and doubt has largely passed, and the electric furnace is beginning to receive general acceptance. In the past, the steel founder has had to rely largely upon the claims of the various electric furnace salesmen. During the past year, the rapidly increasing knowledge of and data regarding electric furnaces have practically eliminated such a condition. Today the steel founder considering the purchase of electric furnace equipment investigates the electrical and mechanical details of each furnace just as closely as he would investigate a molding machine, an air compressor or any other piece of standard equipment.

Satisfaction Assured Purchaser

A year ago it would have been regarded as bad judgment for a steel founder to purchase an electric furnace that was entirely on paper with no units installed. Yet this is being done today, and the risk is minimized, because the steel founder knows that certain combinations are bound to give certain results, it carried out by engineers who are thoroughly conversant with electric furnaces. The electric furnace is today accepted as a standard type of melting equipment, and a steel founder who buys an electric furnace does not buy because of claims and with the fear of experiment; he buys on the strength of the known value of given combinations of features. When any equipment has reached this stage, it has definitely arrived.

Electric furnaces today are in commercial operation in foundries for the following purposes: Melting steel scrap, refining molten steel, melting and refining steel scrap, melting gray iron, melting malleable iron, melting ferromanganese and other ferroalloys, melting copper and copper alloys.

The common use of the electric furnace in the foundry, is for melting down steel scrap for the production of steel castings. The superior qualities of steel castings thus produced, when properly made, have been demonstrated in too many ways for it to be necessary to go into detail here. In some foundries the electric furnace is used for the melting and refining of steel, where an extra high quality of steel is desired, low in phosphorus and sulphur, meeting definite specifications. The Canadian and United States governments are both installing a considerable number of electric furnaces for this purpose, the chief object being the production of steel low in sulphur.

The refining of molten steel taken from bessemer or open-hearth furnaces is not common to the foundry. This process is chiefly found in large steel plants and electric furnaces so employed are usually of larger sizes than are employed for melting down cold scrap.

There has been much talk of the adaptability of the electric furnace for melting malleable iron. It is the contention of many, and a very plausible one, that the silicon and carbon, the important elements in malleable iron, can be more closely controlled in the electric furnace than in the air furnace. Furthermore, it is manifestly possible to hold the heat in an electric furnace whereas in the air furnace the heat must be poured as soon as it is ready. It is also possible to keep the metal up to heat in the electric furnace, while shanking. Malleable iron has been melted in some few cases in electric furnaces, but there is practically no reliable information regarding the results available. It is the opinion of the writer that before long there will be considerable data available regarding the melting of malleable iron in the electric furnace, and that eventually the application of the electric furnace to this work will be as important as it is in the steel founding industry today. The ability to use lower-priced scrap materials for the production of malleable iron in the electric furnace will have an important bearing, as it has had in the melting of steel.

The electric furnace cannot compete commercially with the cupola for melting gray iron. The use of the electric furnace for producing a specially high-grade gray iron, however, has not only been considered seriously, but carried out commercially. The Daimler Motor Car Co., Coventry, England, installed a small electric furnace for the production of a high-grade gray iron for use in aeroplane motor cylinders, and shortly after starting the first unit, placed orders for additional electric furnace units for the same purpose. It is believed that the use of the electric furnace makes a more suitable iron for such cylinders, due to the fact that the sulphur content is kept down, that the metal is melted under conditions ideal for the production of iron free from air holes, and that the iron produced in an electric furnace has the same density that is characteristic of electric steel. There is no doubt that in the electric furnace, by keeping down the sulphur, a higher grade iron can be produced continuously than is now produced in the cupola. The entire matter comes down to a question of commercial practicability; that is to say, whether the higher quality of product justifies the considerable initial investment required and the higher operating cost. In melting gray iron in the electric furnace, the ability to use scrap material will probably feature in reducing the difference between the cost of melting in the cupola and in the electric furnace.

Saving Manganese

The use of electric furnaces for melting ferromanganese is gaining ground, particularly in large steel plants operating a number of open-hearth furnaces. Ferromanganese can be melted in an electric furnace with comparatively small loss of manganese, provided proper slags are employed. One big steel plant installed a 1-ton holding capacity electric furnace for melting ferromanganese for additions to the open-hearth ladles. It was believed that by adding the manganese in a molten state instead of cold, the quantity of ferromanganese necessary for deoxidizing the steel would be reduced by approximately one-third. On such a basis, a furnace would pay for itself in less than a month's time under present market conditions. In this connection, it is of interest to note the results obtained in melting down manganese steel scrap in the electric furnace. The manganese steel scrap employed contained from 12.25 to 12.50 per cent manganese. When molten, and before adding more ferromanganese, the metal contained 11.50 to 11.75 per cent

A paper read at the September meeting of the American Foundrymen's association at Boston. The author, Douglas Walker, is associated with the Booth-Hall Co., Chicago.

manganese, showing a loss of manganese of less than 10 per cent.

The use of electric furnaces for melting of nonferrous metals has not advanced sufficiently as yet to permit of definite statements. For melting brasses and bronzes, furnaces of the direct arc type, indirect arc type and the induction type are employed today. The induction type furnace is theoretically the ideal furnace for this kind of work from the standpoint of minimizing losses, but has the disadvantage that for practical operation it should be worked continuously 24 hours per day, and this does not fit in with the usual practice of brass foundries.

Acid or Basic?

One of the primary questions of the steel founder today, when considering the installation of electric furnace equipment is whether to operate acid or basic. This is a matter entirely dependent upon local scrap conditions and upon the character of product to be produced. The acid process is the simpler operation and requires less technical supervision. On the other hand, with the acid process, it is necessary to use a scrap sufficiently low in phosphorus and sulphur, and there is not the flexibility for producing castings of special analysis that is possible with the basic process. It is the writer's belief that under present market conditions, particularly, electric furnaces for the production of steel castings should be operated basic, irrespective of the comparatively high cost for basic refractories. This opinion is based on the fact that there is today so wide a margin between the cost of the higher grades of scrap for acid melting and the lower grades of scrap which can be melted and refined on a basic hearth. The present market on the miscellaneous grades of steel scrap that can be employed in the basic process is considerably under the market for grades of scrap such as must be employed in the acid electric process if satisfactory castings are to be produced.

In this connection, the writer heard a short time ago of an interesting process which was contemplated. It was described as a reverse-duplex, employing electric furnaces. The idea was to melt scrap and refine it on a basic lining and then transfer the molten metal to an acid-lined furnace for finishing, the assumption being that steel finished in an acid furnace is a quieter metal and more thoroughly deoxidized. Provided acid steel is superior to basic steel, the question is whether the additional cost entailed in transferring the metal and the additional power which would be consumed would be so great as to make the process impractical. As a matter of fact, there is nothing to choose between properly made steel whether acid or basic. Basic steel requires more technical and careful attention, but, given that, it is as satisfactory a steel as acid steel.

Extravagant Claims Discountenanced

Another important change in the attitude of the steel founding industry toward the electric furnace today has to do with the claims for efficiency which are made by the various manufacturers. During the past two or three years, when the electric furnace was just coming into recognition, practically all builders went the limit on claims as to efficiency. Statements as to kilowatt-hour consumption figured as low as 450 kilowatt-hours per ton. It is only fair to say that the same was true in the early days of the converter, the open hearth and practically all melting equipment.

Today the steel founder recognizes that power consumption in an electric furnace is governed by a few elementary points of furnace design, including: The radiating surface of the furnace and the depth of refractory material, the number of doors and the method of closing doors, the number and size of electrodes, the speed of melting down.

The ideal furnace should have:

A combination of minimum practical radiating surface and maximum practical depth of refractory material.

A minimum number of doors commensurate with speedy and efficient working of the furnace and doors of a type that will work easily and close tightly so as to exclude air drafts and prevent loss of heat from the furnace.

A minimum number of electrodes entering the furnace and a minimum practical size of electrodes.

A maximum power input commensurate with practical operation of the furnace and consequently a maximum speed of melting down.

Providing a furnace meets with these fundamental requirements, the further efficiency of the unit depends upon the electrical and mechanical correctness with which the many minor details are carried out.

It is practically impossible to make any definite comparisons as to power consumption of various types of furnaces because there are so many variable factors to be considered. The care taken by the operator of the furnace in killing the metal, the character of the scrap to be melted, the question of whether more than one charging of a heat is necessary to achieve the full-rated holding capacity of the furnace, these and other points all have a bearing upon the kilowatt-hour consumption.

The type of furnace which the steel founder can install is today dependent largely upon the local power conditions. There can be no question that the single-phase type of electric furnace is the simplest and for straight melting down work somewhat more efficient. A considerable number of single-phase electric furnaces were installed in this country during the last few years, when power companies were anxious to secure any kind of electric furnace load. Today the situation has changed, and power companies are very cautious as to the type of electric furnace equipment which they permit on their lines. Cities where the power companies formerly welcomed single-phase electric furnace loads are today refusing to accept such loads. Cities like Cleveland, Toledo, Cincinnati, and practically all the big eastern cities have always refused to take on single-phase furnace loads. For this reason the steel founder is practically restricted to a choice between furnaces of the multi-phase type, or furnaces of the single-phase type operated by motor-generator set. The large additional investment which is necessary, and the larger power losses in the motor-generator set practically put the single-phase furnace so operated out of consideration. The steel founder has then for his choice furnaces of either the three or of the two-phase type. The two-phase furnace, by employing either single-phase transformers, Scott-connected, or single-phase transformers operating on an open delta, gives a balanced load over the three phases of a three-phase line.

Future Furnace Uses

The development of the electric process has been so rapid, and the application of the electric furnace has become so widespread, that it is difficult to surmise just where the future will lead us. There is one significant point, however, which, no doubt, has been given serious thought by steel founders. The writer refers to the fact that a good percentage of the electric furnaces being installed today are being put in by manufacturing concerns that intend to employ the electric furnace either for the production of their own work exclusively, or in many cases for the production of their own work and also for taking on outside jobbing work in small quantities. This tendency has, of course, been accelerated by the fact that many concerns have had great difficulty in securing delivery of castings under the present market and have had to pay well for what they did get.

We can say at this time that the electric process has definitely arrived

and is going forward much further still. The steel founder who installs an electric steel furnace today knows he is buying equipment which, like any other melting equipment, is susceptible to a certain amount of trouble and difficulties, but he also knows that he is buying an equipment which, given sufficient care and thought, will do definite things in a worthwhile way. The cost of operating an electric furnace is no longer a matter of doubt, and the better quality of metal, the important feature of the electric process, is generally recognized to be due to the following factors: The fact that steel can be made more uniform in chemical content and specifications can be met more closely because conditions in the electric furnace and process are manganese, phosphorus and sulphur; ideal for controlling the carbon, silicon, the fact that steel can be made more solid and free from blow-holes because conditions in the electric furnace and process are ideal for excluding oxygen and for producing a "dead melt" by judicious use of alloys; the fact that the steel has a denser structure and a higher tensile strength due partly to the exclusion of oxygen and freedom from nitrogen and partly to the peculiar reaction which occurs in the electric proces.

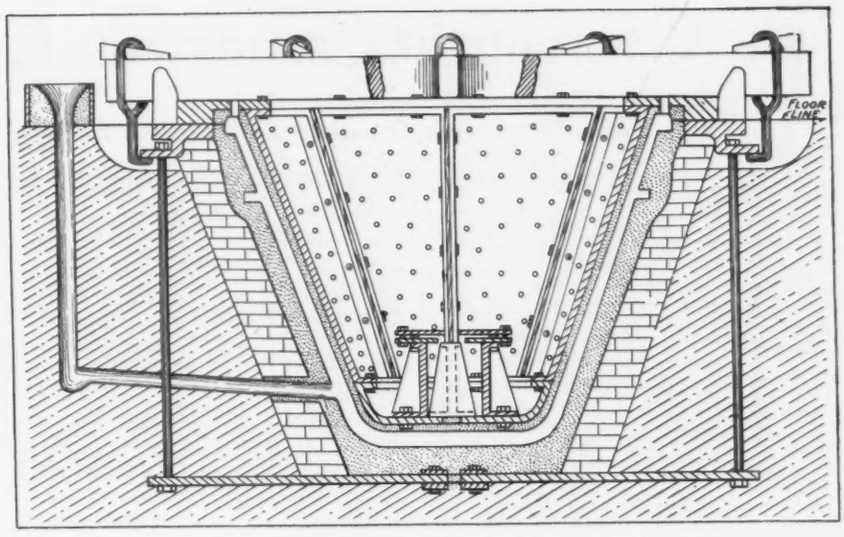


FIG. 2—CROSS-SECTION OF SLAG POT MOLD

Molding Slag Pots in Dry Sand

SLAG pots, or cinder ladles, as they are sometimes called, play an important part in the production of iron and steel, as they form a convenient means of collecting and transporting liquid slag, a residue which in blast furnace practice, exceeds in bulk the weight of iron produced. In the foundry with which the writer is connected, a large tonnage of iron and steel pots is turned out every year. The results are so gratifying, considering the speed and economy of production and the quality of the castings, that a description of the molding process may prove of value to foundrymen.

The iron pots are 8 feet 9 inches in diameter at the rim and 6 feet 8 inches deep. The steel pots are used in open-hearth plants and measure 9 feet 11 inches inside diameter at the rim and are 8 feet 3 inches deep. The molds for both kinds of ladles are of dry sand, and with the exception of the facing sand used, the principles of molding are the same.

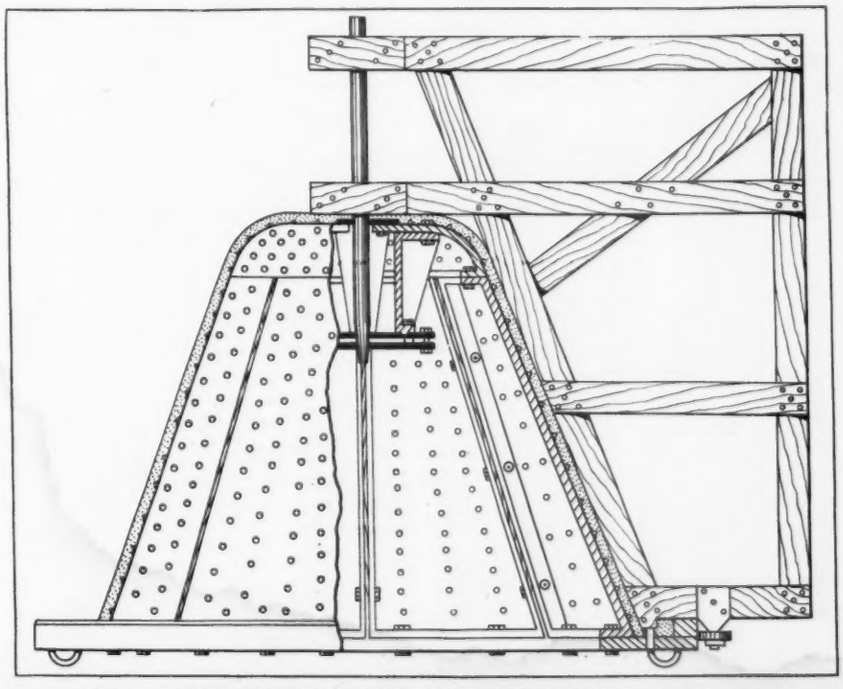


FIG. 1—CONE-SHAPED BARREL ON WHICH COPE IS SWEPT-UP

The cope is swept-up on a cone-shaped barrel consisting of eight flanged segment plates, cast with prickers and cored vent holes, as indicated in Fig. 1. The segment plates are fastened together by bolts, and the upper ends (molding position) are bolted to a flat circular casting, shown at the bottom in Fig. 1. The lower ends of the plates are bolted to a steel ring, which forms the bearing or joint of the cope.

A strip of dry pine, one inch wide and the length of the segment, is inserted between each plate. These strips are burned, thus allowing for contraction in cooling and facilitating shaking-out. The bolts are then tightened, the sweep is set, clay wash applied and the cope is ready for ramming.

The facing consists of one-third new sand and two-thirds old sand with a dry core compound as the binder. The sand is rammed and swept in the usual manner, finished, blacked and dried on the floor with a wood fire under the barrel. The cope is dried during the night.

In preparing the cone-shaped barrel for the steel pot, the wood strips are omitted, and in their place, steel wedges, 4 inches wide, 2 inches thick, tapering to 1 inch, in the length of the barrel, are used to allow for the greater contraction of cast steel. These wedges are set between three pairs of segments on the inside of the barrel. Immediately after pouring, these wedges are pulled by a crane. The castings are entirely free from cracks and shake out easily.

(*Continued on page* 33)

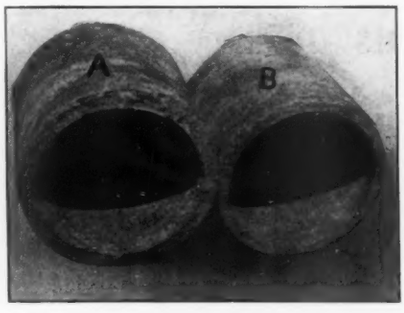
The Overweight Casting---Its Cause and Remedy

A Cure Exists for Every Defect—Conservation of Metal by Proper Molding is a Patriotic Duty Besides Being an Economical Advantage

By R R Clarke

TWO molders working the same pattern produce daily two to four castings per man from it. These castings are fairly heavy, each consuming about two-thirds of a No. 300 crucible in pouring. Two remarkable facts of difference result from their making. Those of the one molder vary from 485 to 505 pounds, while those of the other range only from 475 to 480 pounds. That's the one difference. The other is that the more uniform and minimum weight castings always are better in quality, with preferential differences in appearance and in cost of getting them into merchantable shape.

An analysis of the situation will show that the heavy-casting molder entails a great and, in part, irreparable loss to the foundry. To evaluate that loss approximately in pounds, dollars and cents, might include its practical worth and we shall briefly consider it. At the mold the metal is worth about 22 cents a pound and in getting there suffers an absolute loss of close to 3 per cent, this loss being that of melting independent of waste in handling. In a month's time the molder produces 60 castings thereby overconsuming 1050 pounds of metal, or over two full castings of his making. The loss is 31½ pounds of metal and amounts to $6.93. The foundry producing these castings is a department of the firm consuming them. Instead of shipping turnings back to the foundry for re-melting the firm sells them at their scrap value. Between the price paid for the casting metal and that received for the turnings is a difference of at least 7 cents. The monetary loss per casting thereby increases approximately $120 which amounts to a daily loss of $3.60 and a monthly drain of $72. In a year the molder overconsumes at least 12,600 pounds, loses absolutely 378 pounds and puts the foundry up against an unnecessary liability amounting close to $1000. The effect of 10 molders working on a like basis is readily suggestive of the vast tonnage of metal that can be melted and cast to no purpose whatever, and the great and irretrievable loss in time, money and metal from which the foundry has absolutely no escape. Conservation, at any time, is a foundry duty. At present it stands forth a stern necessity. Some co-ordinating facts already have been brought home to us. We have learned, in part, the effect of war on the metal markets and the abnormal labor shortage super-abundance of production always entails by virtue of the independent spirit and the retaliatory principles it either engenders or intensifies in the laboring classes. Along practically all lines increasing demand and diminishing supply have evolved a harassing consequence of a titanic disturbance in the world's equilibrium. We have suffered merely the inconvenience of the onlooker—a wild and



TWO BUSHINGS MADE BY DIFFERENT MOLDERS FROM THE SAME PATTERN. THE INCREASED WALL THICKNESS OF THE CASTING *A*, REFLECTS ITS OVERWEIGHT AS COMPARED WITH THE CASTING *B*

glancing punch. Under such conditions conservation of all things—time, energy, money and material—is a vital to true patriotism, an essential to the *bit* every man has to do if he wishes to serve his country to the best and most loyal purpose.

On the subject of metal conservation, much has been written detailing different features of the situation and carrying the idea into the everyday practical foundry environment; among those neglected, so far as we are aware, is the uniformity in minimum weight of castings produced. Responsible for a heavy loss from the time of metal charging until the end of machine-finishing the casting, we believe it worthy of analysis and from a strictly practical point of view, shall endeavor to review the situation. In the first place, to the reduction of any long established evil, every foundryman must appreciate the absolute necessity of co-operation, or concerted action involving his whole producing force. To the institution of such co-operation, education and a clear recognition of the common-cause principle are primary considerations. Against corporate interests there is, and long has been in this country, a settled suspicion and opposition on the part of labor. Though always suppressed in expression, the feeling of labor has been more or less sub-surface active that between it and the firm, antithesis rather than commonism prevailed; that to do anything good for the firm was not for labor, nor anything against the firm against labor, so long as not too pronounced or determined by the firm as an intentional offense. These statements involve no accusation of the willful and malicious purpose of labor; they do, however, entail a strong suspicion of voluntary indifference on the part of a great many workmen, an indifference, which like the tuburcular germ, could not long endure in a better light and atmosphere of thought.

We might illustrate the argument. We remonstrated with a molder once for cutting a lip of undue depth on a crucible thereby depleting its capacity unnecessarily. He replied that the firm was rich enough to stand for a little mistake and made enough money out of his labor to cover it several times over. The man was absolutely wrong. In the first place, it was not a mistake, but blind indifference, something he neither meant to do nor intended not to do; furthermore, it was no trivial matter, but rather a case of depleting a crucible by 25 pounds at a single pouring, which repeated a half dozen times, would almost decimate that capacity. Wasteful and expensive evils of magnitude are not much feared by the manufacturer of standard repute, because in his system are corrective measures automatically assertive. The apparently trivial affairs are those with which he must regard issue most imperative, and these are the most deceiving to the management and are farthest removed from the thought and care of men. Against all such conditions organized and

concerted action must proceed along new lines of co-operation, leading from enlightened conceptions of accepted responsibility and falling under the full control of the common-cause principle. Men must be taught new values and all their co-ordinating significance. They must be led to the clear understanding that the present and legitimate advance in metal prices is an expression of an exhausted supply, either temporary or absolute, which represents a situation in which the purchasing power of a firm, however great, has absolutely no standing. They must be impressed, also, with the great need of full-quota production from every producing unit and the moral criminality of detracting in any degree from the results of their own and other men's labor, or of adding thereto in either unnecessary expense or effort.

Heavy Rolling Stock Demands

To exemplify, we might refer to the case cited in the introduction. The casting in question is made of a copper-tin-lead alloy and does important service in the running gears of a locomotive. Every man of ordinary thinking capacity readily preceives the tremendous importance of transportation in the present crisis. Every railroad foundryman has long felt the hard strain of keeping pace with rolling stock demands and can have positively no doubts regarding those demands in the immediate future. Here we have a molder producing the very castings for which the railroads fairly beg, and in so doing over-consumes 12,600 pounds of metal a year that means that this bulk of metal has to be bought, loaded, shipped, unloaded, stored, weighed-up into heats, taken to the furnace, melted, poured, cleaned, weighed-up again, loaded, shipped, unloaded, taken to a machine and turned and milled away, all to absolutely no purpose. To the same purpose so much fuel, power, wear and tear on manipulating devices and hundreds of other little incidentals have to be similarly accounted for. More serious still is the great loss of possible castings. Consider, for instance, the locomotive main pin bushing for which an extremely heavy demand always exists. In the rough, this casting in the larger type of locomotive, averages close to 100 pounds. Under good metal-consuming conditions, this yearly excess of 12,600 pounds of metal could be made to yield 126 such bushings, or enough to equip or repair 63 locomotives in this particular. Since melting capacity has become more than ever a basic criterion of producing power, the criminality of such unwarranted waste becomes the more conclusively established.

Now these are the facts, the elementals of fact, that the molder must be taught to appreciate to formulate a new co-operation on stable foundations and beyond the power of old-time feeling or condition to undermine; that the country more than the railroads needs the bushings and must have them; that the foundries of the land are pressed to the limit under most distressing conditions to supply them and that it is up to him as a workman-citizen to get in touch with the real situation, appreciate its gravity, accept individual responsibility and to resolve to co-operatively strive for more substantial results from his own labor. That spirit is absolutely imperative and must materialize if the producing units of the country along any line are to cope with the developing situation. Every day we are getting such messages as this: "Our order 1352, 6 connecting rod bushings X9253, Eng. in shop, ship by passenger train quick, advise." It's a bad time for railroads to have engines "in the shop" and we want to do our utmost to get and keep them on the road, but we will have to have the full-souled co-operation of our depleted army of workmen to do it. The present is a hard test of systems, carrying with it a most disastrous repudiation of weakness or lack of system. The other day we were talking to the head of a representative manufacturing concern. On present conditions more or less universally felt he had this to say: "There are many little things in our plant and system not right, they never were right and are showing up against us now. Under normal conditions we could have corrected them. Now we are powerless to do anything for fear of men quitting and leaving us in the hole." That's the situation exactly, and is it not a sad commentary, suggestive of the great need of remedy that at a time when air-tight systems are most imperative, the spirit of labor is least inclined to abide their reasonable exactions? That any such remedy must be tardy and unsatisfactory under the prevailing system seems a logical certainty. Under stress of competition, manufacturers are putting a big premium on labor and placing the market on an auction block basis. Waiving the privilege of argument, we suggestively refer to the possible advantages of a uniform labor rate, a more profound respect among manufacturers for the rights and privileges of each other, and more drastic national measures against the habitual loafer. That the necessity for and benefits of organized co-operation justify the co-operation measure, derives decided conclusiveness from the foremost thinkers of the day. On April 11, this year, the presidents of the great railway systems of America met in Washington to jointly consider ways and means of handling the great and sure-coming problem of transportation. It was a significant action they took, these broad-minded, far-seeing and practical men, when they *"Resolved:*..That the railroads of the United States, acting through their chief executive officers here and now assembled and stirred by a high sense of their opportunity to be of the greatest service to their country in the present national crisis, do hereby pledge themselves, with the government of the United States, with the governments of the several states and with one another, that during the present war they will co-ordinate their operations in a continental railway system *merging during such period all their merely individual and competitive activities in the effort to produce a maximum of national transportation efficiency.* To this end they hereby agree to create an organization which shall have general authority to formulate in detail and from time to time a policy of operation of all or any of the railways, which policy, when and as announced by such temporary organization, shall be accepted and earnestly made effective by the several management of the individual railroads."

Railroad Employes Admonished

Equally impressive is the language of Samuel Rea, president of the Pennsylvania system, in distributing circulars to the 250,000 employes appraising them of the steps jointly taken. In part he has this to say: "Only by great personal interest and effort on the part of each man will the railroads be able to meet the extraordinary transportation needs of the country which have become more acute since the entrance of the United States into the war. I am exceedingly anxious that the Pennsylvania railroad system shall do its full part in the work which the railroads' war board has outlined and I urge upon every officer and employe to assume his share of the responsibility in this grave crisis. At the outset railroad men know that there is a scarcity of labor and traffic is congested. They can do much to offset these conditions by increased freight car and locomotive efficiency. * * * To make every car do a full day's work every day in the year *we must persuade shippers to load and unload cars promptly and to increase and improve their sidings and*

facilities for that purpose." Analysis of the whole affair shows its outstanding failures to be the recognized power of organization and the basic necessity of getting down to and impressing the units of systems with the indispensability, responsibility and accountability each and every man is duty-bound to accept. The foundries of the land can make no mistake in taking a similar view of the situation and subjecting all measures of remedy and increased efficiency to the same principles of formulation. The ideals of organization and producing system are those in which unit of power develops a maximum efficiency along lines and from motives of common cause and benefit, and these are the lines and the motives along and from which many foundry problems will have to be worked out in the impending crisis.

Conservation in the Foundry

But we must go down into the foundry and locate the manipulative source of the over-weight casting. We want to get at the cause, knowing that if we remove the cause the effect will be sure to disappear. To begin logically we might consider in detail the casting, shown in the accompanying illustration, and its method of molding. It is a plain bushing of open and drum, 20 inches outside diameter, 17 inches inside diameter, and 17½ inches long. The walls, therefore, are 1½ inches thick. The pattern makes its own green sand core, is molded vertically in a three-part flask and is gated at the bottom. This flask is 25½ inches square inside measurement, has a 4-inch drag depth, 17½-inch cheek depth and a 6-inch cope depth. The molding process consists in first ramming-up the drag and making a level parting. The pattern and gate are then set and the cheek of the flask placed and rammed. The second parting, cope to cheek, is then made and the cope-tamping executed. The cope is then taken off, the pattern and drop gate lifted, the cheek lifted from the drag and the entire mold is well slicked with plumbago. Following assembling, the mold is clamped and poured hot from a conservatively high-in-lead, copper-tin, alloy. Given approximately one hour to cool, the casting is shaken-out, cleaned and chipped ready for the shipping room. Such is the general molding plan which, so far as our foundry judgment enables us to determine, is representatively indicative of good practice.

Comparison is a great instrumentality toward the details of knowledge. By it a vast collection of useful facts have come into human possession and set right more than one erratic motion or practice. Here we have at hand two molders differentiating widely between the status of their respective castings derived from the same pattern. By superficially referring to their respective details of daily practice we might discover some significance in these details explanatory of the difference in status referred to. The one molder is much more systematic than the other. His floor is invariably clean and orderly—the other's generally chaotic. In him the sense of precaution and the power of deliberation are much more pronounced. He works thoughtfully regardless of the nature of the pattern, or his familiarity with it and is no more of an automatum today than the first time I ever saw him handle a rammer which was some half dozen years ago. Of the other, this cannot be said. Molding with him is primarily a habit retaining all the governing powers of habit whether for good or evil, and neither adding nor detracting from his routine-derived knowledge and skill in the art. It is just as hard for him to discard a bad practice as it is to reason to or formulate an additional good one. He makes a mistake once, corrects it temporarily and then turns right around and makes it over again. If habit were always formed along right lines and operated in strict duplicate of detail, this man would be the best or the worst molder in the universe. He is neither, but instead, to a marked degree non-dependable.

How Intelligence Operates

Now that's the difference between operative intelligence and automatic control. The man has intelligence, but seems powerless to exercise it. The great task is to convince him that God gave him something very useful in the molding trade. Out of this fundamental difference in the men arise many distinctions in their practice. The one takes good care of his flasks, his bottom boards, his clamps and all other items of equipment entrusted to his care and use. Every day or so he can be seen examining the flask with a view of determining its continued state of strength and rigidity. Likewise with his clamps. To his sand pile at the end of each day he adds new sand and cuts it thoroughly into the old. The next morning he cuts it all over again before starting to work. He riddles at least 50 per cent of all the sand he uses. This sand he works rather dry, but never without the best of the body. He rams harder, more uniformly, and logically with respect to position. Instead of filling his flask half full of sand and then smashing away at it in steam-hammer style, he fills it up to some 8 inches around the bottom, tamps consistently and then fills it up again for a repetition. The outside of the mold he rams up first, raps the pattern from top to bottom on the outside with a rubber mallet and then rams up the core. In drawing the pattern later, very little rapping is done and that uniformly with respect to different directions. In dressing-up the mold, soft spots are felt for and if found are hardened by trowel-dressing. Plumbago is not merely sprinkled or brushed on, but rubbed well into the sand. Copes are always hand-rammed and well-barred with no loosening of the bars permitted to pass. In pouring the metal, the stream is started slowly and then increased to maximum capacity until the mold is nearly filled, when the volume is again reduced and the metal brought to the gate top level slowly and cautiously. Another significant item is that his pattern invariably occupies an approximately central position in his flask.

How the Other Molder Does It

That's the way the one molder does it. As for the other, he is not so receptive to particularity. The difference is indicated by the fact that he wets his sand down as shaken-out in the evening, roughly shovels it up and lightly cuts it over the next morning; he fills his flask two-thirds full of sand and then starts to ram, consequently failing to realize a uniform and solid state in the lower vicinities of the mold; he never stops or slackens in pouring his mold until the metal, over-running the gate top, prompts him that the mold must be full and he doesn't notice a weakening flask or a loosening bar until after a run-out or a fall-out forces his attention to them. These are a few of the great number of inconsistencies forming a part of his continued policy and detracting from his status as a molder as well as adding signally to his troubles. Consequential to these differences, the one molder produces almost uninterruptedly a clean, smooth, solid, true-to-pattern casting with no difficulty not calculated on, besetting his daily progress, while the other is constantly fencing some misfortune such as run-outs, fall-outs, patching, etc., thereby losing time, castings, money and prestige and burdening the consuming market with a product beneath its possibilities in every respect.

Remedial measures mainly have three subjects to consider; they are those of quality, of condition and of method. In dealing with the over-

weight casting each and all of these have a pronounced significance. The quality and condition of pattern, flask, board, clamp, sand, metal, etc., argue strongly in the matter of minimum weight uniformity, while method of tamping, rapping, positioning and drawing the pattern, as well as dressing, clamping, weighting and pouring the mold, contend none the less persuasively to the same end.

The Importance of Patterns

With what degree of importance each is invested we shall examine briefly and in order. Pattern influence over casting uniformity is dependent upon the pattern's immunity to swelling and warping and its power to resist the attacks of hard and continuous service. In these properties the metal pattern is decidedly strong and shows to great advantage in practice, approximating in our judgment the ideal type of pattern in all cases where its adaptability is at all possible. Especially are we partial to the aluminum shell pattern, which in weight can be made to rank with the wooden pattern, and in durability, far outclasses it. Under the very hardest conditions of service, such as heavy jolt-ramming might exemplify, we have found these patterns to be 100 per cent efficient and to give stable promise of an all but endless resistance. That no little expense and trouble forms an initial part of such patterns is no argument against them since on their efficiency and ultimate economy, no well-founded suspicion can for a moment be entertained. Wooden patterns are not so fortunate. By both use and disuse they suffer, to say nothing of misuse. All the quality of material and efficiency in construction, therefore, should be accorded them. The lumber should be well selected, seasoned and in pattern form, protected. Split patterns warping increase their parting dimensions, adding to volume and making possible an upward shift in cores those patterns might involve. The same casting inequality of joining surfaces and a similar casting consequence easily can arise from the molder's rapping bar or draw spike operating in the wood of the pattern. Against this the metal rapping plate firmly inset is an efficient protection and should form a part of every pattern sufficient in size to warrant. In making separate the different parts of patterns and joining them to the body, or in building-up a pattern form, the best grade of adhesive material and the strongest binding constructive principles always should be considered. Adjoining parts of patterns often recede from their original position against the pattern body, leaving an open crevice. Molders frequently fill this crevice with bees-wax and go ahead using the pattern, little considering the increased dimension and volume in the casting resulting from the practice.

In the presence of moisture practically all wooden patterns swell, varying in degree with the nature and condition of the lumber used and the pattern's surface protection against the penetrating power of moisture. Shellac usually forms this coating and should be of best quality, evenly and consistenly distributed, well dried and frequently renewed. A practice commonly observed is to apply shellac only to sand-engaging parts of split patterns, leaving parting surfaces unprotected. In water-brushing the edges of such patterns prior to drawing them, molders too often slop water all over these unprotected surfaces, an enlarging pattern resulting. Bottom surfaces and edges of a pattern are open to the possibility of being bruised or burred by the rammer. These burred edges invariably produce a scar in the mold, the scar materializing when the pattern is drawn. The condition associates intimately for instance with bushing patterns making their own core and molded vertically and always sponsors a rough and over-weight casting. Metal face plates attached to these surfaces can be relied upon to protect them and add strength and durability to the pattern as well.

Poor Pattern Causes Patching

From the condition of a pattern often arises the necessity of patching the mold, a circumstance generously contributing to the out-of-shape and overweight casting. "Better a fin or too much metal than a crush or not enough" is the molder's philosophy and the full 100 per cent of them accept it. Few if any wooden patterns, doing hard and continuous service, can be relied upon to retain absolutely their shape or dimensions, and those subject to long periods of storage, intervening short periods of manipulation, are not much more promising.

The invited consequences of a weak or unstable flask, of a non-dependable clamp, of insufficient weighting, of a bottom-board uneven in surface or of wide crevices, or one poorly fortified with batting, of bodily-impoverished sand, of low quality metal requiring a tremendous gate pressure to overcome cope shrinkage, etc., are all too obvious to warrant extended comment. Sufficient to say that the searching power of liquid metal will find every such weakness and unfailingly take advantage of the situation to increase its bulk in the casting over and above that calculated. The method of executing the detailed tasks of molding has everything to do with the casting status.

Handling the Sand

The only way to manipulate sand is to have it free from lumps and in best of mixed and tempered condition, strictly uniform throughout; to fill the flask to that depth only that will insure to the lowermost particles the full effect of the tamping; to add and tamp consecutive fillings by the same principle and to rely on repetition rather than brute force of stroke to produce a uniformly solid state. No hand tamping can proceed through a 16 to 24-inch depth of lumpy sand and approximate consistency of effect. The logically tamped mold observes a cushion effect in the metal-engaging sand surface terminating shortly in a hard and rigid background, all of which can be realized by approaching to within approximately 1 inch of the pattern in tamping. From the middle point of extremes the author has always inclined to the hard rather than the soft-tamped mold. To the former scabbing, shrinking and misrunning are casting possibilities; to the latter, washing away, sand-burning and swelling almost certainties. As to the first named our molding experience has been that all three derive as fully and surely from poor condition of sand, illogical tamping method and bad gating and pouring practice as from a mere condition of hardness. A fallacy sometimes entertained is that broad or deep, thin castings, by virtue of their lightness, enjoy a degree of exemption from swelling. The principles of liquid metal pressure repudiate the idea and caution against any practice that might come from it. For experimental purpose, the author once had a thin strip, 30 inches long, molded vertically, gated at the bottom and poured from aluminum. The lower section of the casting was badly swelled. The molder had not calculated on the high pressure at the bottom of the mold in even so light a metal as aluminum.

Much additional metal can accrue to a casting by the rapping and drawing of the pattern. Some molders could do little worse with dynamite than they do with a rapping bar. Excess pattern rapping not only enlarges the mold, but breaks up its sand compactness by which the metal pressure operates to a still greater casting enlargement. Deep, heavy-casting

patterns should include a provision for bottom-rapping in the process of ramming-up. Very little top-rapping is then required. In lighter classes of work where strict uniformity is sought, no hand rapping should be attempted, but instead, that of the pneumatic or electric vibrator which can be advantageously placed either on the bench or the pattern plate, or the flask or bottom-board. For your own benefit, try the vibratory rapping effect of a strong vibrator temporarily attached to a deep, heavy-casting pattern in the mold, attaching the vibrator on the pivot principle and swinging it around to operate in different directions. The rightly-made pattern in good condition needs but little rapping and any pattern requiring excess rapping should be corrected at once. In drawing patterns, draw-spikes should be sharply pointed and carefully driven into the wood to avoid driving the pattern further into the sand. Square pointed give better service than round-pointed spikes while a slightly roughened rather than a polished surface back of the point yields a similar advantage.

Too much importance can scarcely attach to proper dimensions of flasks and the correct positioning of the pattern with respect to those dimensions. A pattern too close to the sides of the flask seldom gets proper tamping, while one too far away is just as liable to escape it. It thus will be seen that by bad pattern position in a correctly dimensioned flask, two chances of an inferior casting are at hand. Shallow sand over either the cope or drag of a pattern is the worst of practice, casting swelling the run-out and the fall-in, all three resulting. The use of frames is logical if logically planned and executed. Frames joining flasks temporarily should fit close at all points of contact with the flask edge and never be used unless such contact prevails.

Frames without lugs admit the possibility of shift in manipulating and consequent mold-sand disturbance, which in turn favors the out-of-shape and over-weight casting. They are not nearly so correct or commodious as the frame including the lug. The most stable guarantee to the security of a mold in pouring is the clamp admitting to its grip the bottom-board and the top of the mold. In clamping, it is bad practice to neglect the gate vicinity, to draw clamps away from instead of toward the gate, to first clamp one side tight and then draw the other, or to arrange clamps with a possible pivotal effect on the flask. To guard against a cope-raise as deriving from gate pressure, a plate clamped over the mold top surface is 100 per cent more assuring and efficient than a weight, it being understood that the plate sets perfectly level and bears on the flask edge touching lightly the sand surface. The lifting of a cope at any point in pouring always involves an enlarged casting since the cope seldom, if ever settles back to normal position. This raising usually occurs at the gate end of a mold and suggests the advisability of fully protecting that end. In weighing flasks for pouring, care should be taken that units of weight are close joining permitting no open space between them, especially over broad casting surfaces under heavy gate pressure. It is safe policy also to have more than enough weight since only under exactly duplicate conditions will gate pressure observe uniformity, variation attending difference in specific gravity of alloys, degree of fluidity, etc.

Preparing the Mold

As to mold patching, it is a thing to be discountenanced and guarded against in pattern construction and condition and in a molder's sense of security in working the mold. Some molders are adept at patching and dressing, but it is gradually receding from the hurry-up systems of the day to bide the time and inconvenience necessary to the proper execution of this feature of molding.

Dry facing a mold is an art on which much of the cleanliness of a casting, its immunity to sand-burning and the security of the mold depends. It's a hard job involving a heavy expense in time and metal loss to get a severely sand-burned casting down to reputable appearance and minimum weight. Facing material, whether talc, plumbago or whatever is used, should be well rubbed into sand surfaces with a light and artistic touch. To dust or brush it on is merely superficial admitting its washing away and otherwise all-around efficiency. In pouring a deep mold gated at the bottom, the metal acquires an upward motion and consequent momentum. Added to this force, is the driving pressure in the pouring gate. These forces suddenly applied to the cope of a filled mold will invariably strain a casting and often lift a cope from off its seat on the drag, even in horizontal position of casting and under heavy weight. To appreciate the argument, lay a flat core over the top of a riser, pour the mold hard throughout and note the effect on the core. Therefore, it is logical to cut down the pouring stream as the mold nears its filling and to resort to the riser as an additional medium of relief.

Core room practice figures prominently in the case, the grade quality and adaptability of sands and washes along with the core box method and the condition of the box engaging special prominence. A lone instance will suffice to illustrate. A core for a bushing is made in a half-round box, the halves being dried separately and pasted together. The surface of the box wears down by service; the coremaker rubs the two halves together to realize true joining surfaces in pasting together. Both processes reduce signally the diameter of the core and consequently increase the volume of metal surrounding it in the casting. By machine-molding, many overweight castings can and no doubt are being produced in different foundries. The situation is no doubt a consequence of bad conditions of equipment, the wrong method, or the wrong machine. Every type of pattern has some tamping requirement to which some order of power tamping is especially adapted; the jolt or the gravity for the deep pattern, the squeezer for the shallow, etc. To reverse the order of things in machine-molding opens the possibility of the evil under discussion. Patterns are sometimes given undue draft necessitating base enlargement to avoid a stripping plate or some other mechanical medium of assistance to clean lifting when the initial cost and trouble of realizing the medium is the only argument for the excess draft and heavier casting. Variations in the density of ramming by the squeezer type of machine are frequently realized by under-strips advantageously placed on the squeezer head or board. In bad condition, these boards cannot be expected to produce that sand density, nor control the swelling tendency of the casting.

Considerations thus far submitted apply *in purpose* only to the green sand molding method. That the dry-sand mold dominates the situation much more completely is readily admitted. That the permanent mold in different instances and classes of work has still much further to offer, we are perfectly aware. These methods, however, are subjects of themselves. Many important items of detail attach to each and we prefer to leave them to some possible future occasion. Few foundrymen are willing to admit that their castings are far from uniform. In a great many instances it is only those castings against which specifications of weight are binding that they know anything about.

The Evolution of Cooking and Heating Stoves

The Early Attempts of Our Forefathers in Stove Making Appear Ludicrous When Viewed from the Light of Twentieth Century Development

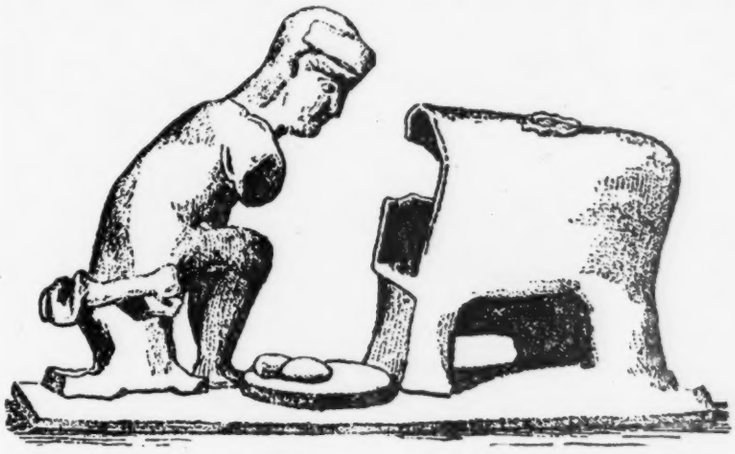


FIG. 1—A SPARTAN OVEN, 600 B. C., FROM AN ANCIENT GREEK TERRA COTTA STATUETTE

FOR the purpose of cooking, crude stoves were devised thousands of years ago, and among the ancient relics that have been unearthed, from time to time, are found crude stone and clay stoves that were made to serve the purpose of cooking food for prehistoric man. Devices designed for heating purposes were devised long after so-called cooking stoves were introduced and some of these unique designs are illustrated and described in a brochure by Fuller & Warren Co., New York, entitled "The Evolution of Cooking and Heating", of which H. H. Manchester is the author. The Spartan oven dating back to 600 B. C., is illustrated in Fig. 1. This print was made from an ancient Greek terra cotta statuette. The crude form of stove carved from stone, evidently was fired from the inside and in the foreground on the stone is shown the food to be cooked. In Fig. 2 is illustrated a brazier with one of the earliest types of waterbacks, unearthed from the ruins of Pompeii and now in a museum at Naples. A Greek grill, 500 B. C., is shown in Fig. 3. This print represents a terra cotta statuette and shows the crude form of grill which evidently was the forerunner of the type of grill in use today. An advanced step in the form of cooking utensils is illustrated in Fig. 4. This depicts the preparation of food for a feast in Italy, some time in 1600. It will be noted that kettles were used at that time, evidently having been made from copper. Another method of cooking is illustrated in Fig. 5, which shows this practice in Italy in the sixteenth century. Two spits are illustrated on either side of the kettle and it will be noted that the kitchen is hooded to carry off the fumes.

One of the first types of heating stoves is illustrated in Fig. 6. This shows the Franklin stove in 1744 and it will be noted that several rectangular pipes were provided to disseminate the heat before the waste gases reached the flue. A manuscript miniature, showing another type of heating stove, with a stork's nest on top, about 1340 A.D., is illustrated in Fig. 7. A Gothic heating stove of 1504 is illustrated in Fig. 8. These stoves, sometimes made of tile and sometimes of iron, frequently reached from the floor to the ceiling. It will be noted that the stove is highly ornamented throughout. The early introduction of the stove pipe is shown in Fig. 9. This stove was installed in a French sugar refinery and the print is dated 1760.

Philo Penfield Stewart, whose name is identified with the development of the modern stove, was born in 1789. He early showed a tendency toward mechanics, but dropped his work to become a missionary among the Choctaw Indians in Mississippi. After his return in 1832, he fashioned a sheet iron cooking stove which he called the Oberlin. His first idea for the Stewart "summer and winter cooking stove" was developed in 1836. This had a fire box hung in the oven, the flame passing down the front, along the bottom and up the back so as to distribute the heat uniformly. The early use of the hot water tank is illustrated in Fig. 10. It will be noted that this stove contained a baking cover and warming oven with means for heating water and conveying it to the barrel hot water tank, superimposed upon the stove. A cooking stove of the civil war period is shown in Fig. 11. It will be noted that the oven is elevated, as were indeed other cooking stoves of that period. A highly ornamented heating stove of the period of 1830 is shown in Fig. 12. One of the

FIG. 2—A BRAZIER WITH A WATERBACK, NOW IN A MUSEUM AT NAPLES

FIG. 3—A GREEK GRILL, 500 B. C., FROM A TERRA COTTA STATUETTE

FIG. 4—PREPARING A FEAST IN ITALY, LATTER PART OF SIXTEENTH CENTURY

FIG. 5—BOILING IN A LARGE KETTLE FOR A BANQUET, ITALY, 1600 A. D.

earliest types of the Stewart range in use from 1832 to 1848, is illustrated in Fig. 13. It will be noted that the hot water tank is on top of the stove and is heated by the gases passing through the pipe in the center. Water was drawn off from the faucet at the side.

Another Stewart range which has been in use for a period of 45 years, similar to the design of 1832, is illustrated in Fig. 14. The waterback is spacious and the warmer is shown directly underneath. The water was heated by the pipe passing through the center of the waterback.

A cooking stove of the civil war period is shown in Fig. 15.

Figs. 16, 17, 18 and 19 are views of a stove plant in France, showing the advancement of the art in 1870. In Fig. 16, one of the workmen is engaged in finishing a figure for decorating stoves, and in Fig. 17, which evidently is the sheet metal shop, stove pipes are being riveted. Fig. 18 is a view of the assembling department, and in Fig. 19 parts of the stove are being finished for the assembling room.

In discussing the evolution of cooking and heating, with special reference to cooking and heating stoves, H. H. Manchester writes in part, as follows:

"Cooking and heating go back at least to the Glacial Age, probably 50,000 years ago. In the caves of Altamira and La Madeleine, on the border of France and Spain, have been found the partially burned bones of the mammoth and European bison, while pictures of such extinct animals on the walls prove the presence and instrumentality of man. The fire of that age was merely an open one. Meat was roasted on spits over the embers. Boiling was accomplished by filling a hollow in the rock with water, which was heated by throwing hot stones into it. Possibly they also used vessels scooped out of sandstone, a few of which have been preserved.

"The first positive evidence in regard to equipment for cooling, dates from Egypt and the dawn of history about 6000 years ago. Among the wall paintings of the rock tombs, in which the ancient Egyptians portrayed almost every aspect of life along the Nile from 4000 B.C. to 1000 B.C., there are a number illustrating the preparation of meals.

"The earliest and most primitive of these are representations from the Fourth Dynasty, about 3500 B.C., of shepherds broiling on spits and baking cakes in the ashes. Boiling in

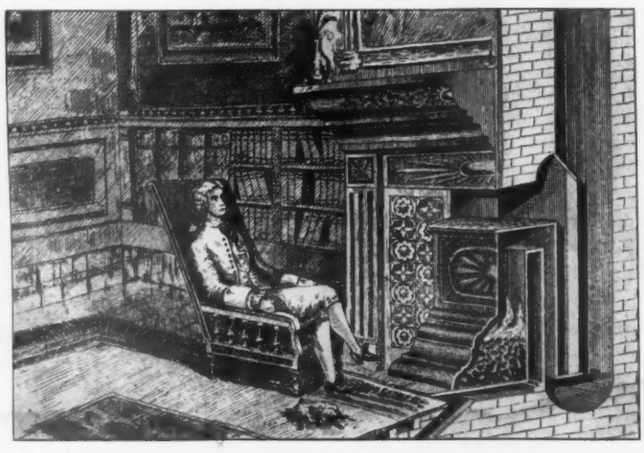


FIG. 6—FRANKLIN HEATING STOVE, 1744

FIG. 7—A MANUSCRIPT MINIATURE DATING BACK TO ABOUT 1340 A. D., SHOWING THE FIRE AND CHIMNEY WITH A STORK'S NEST SURMOUNTING

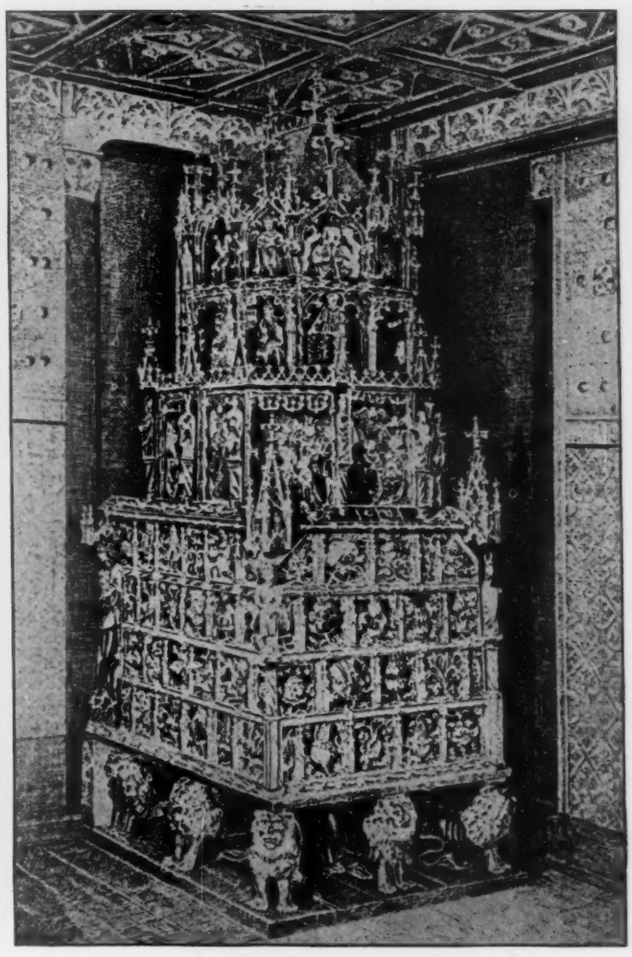


FIG. 8—A GOTHIC HEATING STOVE OF 1504. SUCH STOVES, SOMETIMES MADE OF TILE AND SOMETIMES OF IRON, REACHED FROM THE FLOOR TO THE CEILING

kettles is not represented in such early pictures, but as pottery goes back to prehistoric times, undoubtedly this method of cooking was also employed. About 1600 B.C. the kitchen had become a department of great importance, as proved by large paintings showing the details of the royal bakery and kitchen of Rameses III. These portray boiling in pots, frying on a griddle, and baking on the outside of a cylindrical oven. Thus even as early as ancient Egypt we find at least six different methods and types of equipment made use of in cooking.

"The climate of Egypt made the heating of the habitation of minor importance. Occasionally pots of charcoal were set in a room on a chilly night, or the family slept around the oven, which would radiate some heat even after the fire in it had died down. In neither cooking nor heating was there any provision made to avoid the smoke. There were no chimneys, and, if the fire was inside the room, the smoke was left to find its way as best it could out of the door, window, cracks, or a hole in the roof.

The result was a waste of fuel, which was already scarce in Egypt, and various diseases of the lungs and eyes. "In ancient times, a room in Mesopotamia was heated by means of a little brazier or pot filled with charcoal. Later, such a pot was buried even with the floor, the top covered and a rug spread over it. Under this rug the family would crawl for the night to get the benefit of the heat, in spite of the dangerous gases which unavoidably rose from the charcoal. In Homer's time the meat was roasted over the fire as at an old-fashioned barbecue today. Homer tells how Ulysses kindled the fire, Achilles turned the spit, and Patroclus drew the wine.

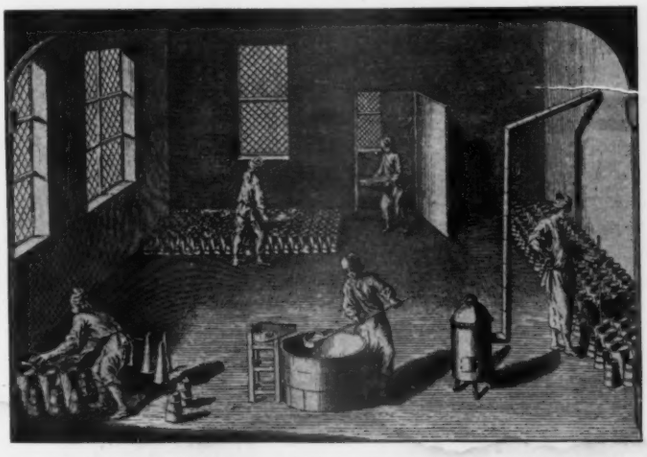


FIG. 9—A STOVE AND STOVEPIPE IN A FRENCH SUGAR REFINERY, 1760

"An indication of the early methods of heating in Greece is given in the Odyssey, book XIX, where Penelope's maids are described as throwing the embers out of the braziers upon the floor, and heaping fresh wood upon them. In the classical period, charcoal was used for fuel, and gum, spices, or bitumen burned to add a pleasanter odor to the smoke. It was in

FIG. 10—A STEWART RANGE IN USE 45 YEARS

PHILO PENFIELD STEWART

FIG. 11—HIGHLY ORNAMENTED CIVIL WAR PERIOD STOVE

FIG. 12—HEATING STOVE OF 1830

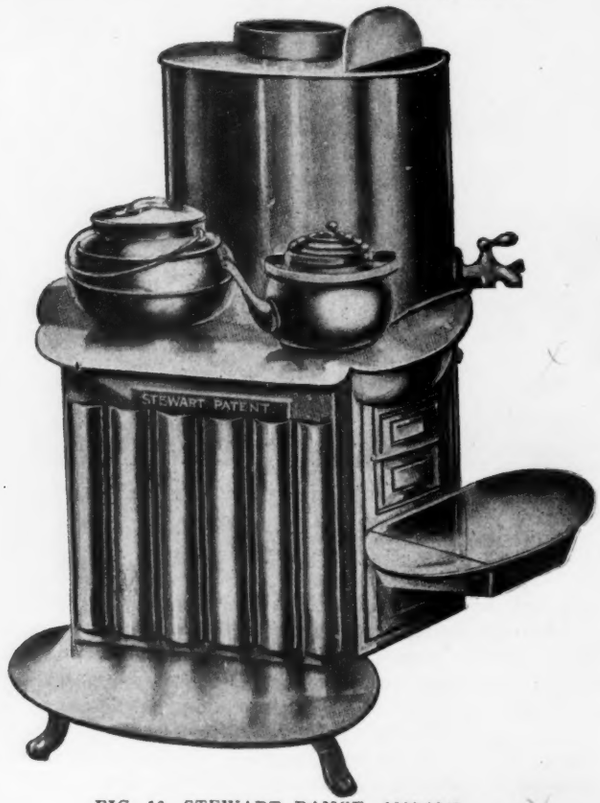


FIG. 13—STEWART RANGE, 1832-1848

FIG. 14—WHEN A BARREL WAS USED FOR A HOT WATER TANK

FIG. 15—A COOKING STOVE OF THE CIVIL WAR PERIOD, WITH ELEVATED OVEN

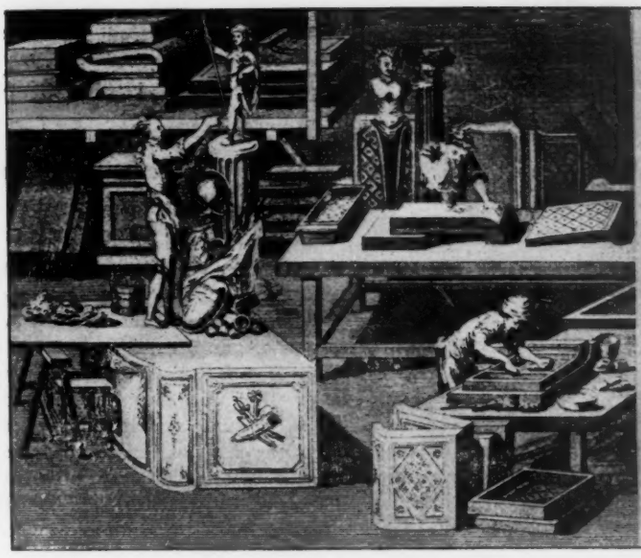


FIG. 16—DEPARTMENT OF A STOVE PLANT IN FRANCE, 1780

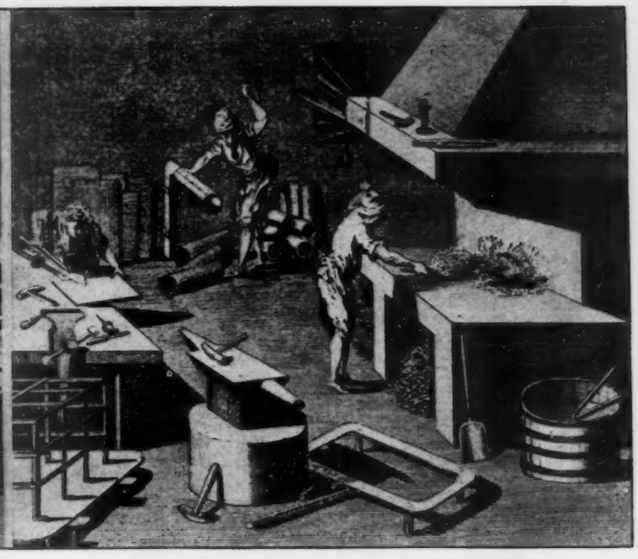


FIG. 17—ANOTHER VIEW OF THE STOVE PLANT, SHOWING THE PIPE MAKING DEPARTMENT

the equipment for heating that the Romans made the most remarkable improvements. As Seneca wrote, 'Many inventions have come within my memory—such as windows made of transparent plate, suspended baths, and pipes from hypocausts so inserted into the walls as to spread an equal warmth through the room, and heat what rooms are beneath as well as above.'

"The hypocaust was invented by Sergius Orata about 100 B.C. It consisted of a low basement chamber, at the entrance of which was burned the fuel. This warmed the room above, and from this chamber flues were often led along the floors and upward inside of the walls to other rooms. It was adapted particularly to the baths which were developed so elaborately under the Empire. In a bath, the cold water was run from the roof into a vessel or tank, where it was heated through a long upright flue from the hypocaust and in certain rooms used at this temperature. To warm this water further, it was siphoned from the first tank into a second one, not so far above the hypocaust, where it was heated through another flue. To be made still hotter, it was drawn from the second tank to a third one having a short flue running down to the fire. Thus the bath was constantly supplied with cold, tepid and scalding hot water. Another method of heating the water was by sending it through *dracones* which were coils of thin brass pipes passing through large jars where they were subjected to the heat of the flames. The action was very much the same as in the instantaneous water heaters of today.

"Relics from Pompeii prove that the braziers often had places for water tanks at one end, somewhat analogous to the waterbacks of the modern ranges.

"Although so much attention was paid to luxuries in the baths, the private dwellings of the Romans had few conveniences in regard to heating, even in the better villas in the colder provinces where artificial warmth would be most needed. Pliny's villa had only one chamber that could be heated artificially, while the Emperor Julian wrote that in the palace which he occupied at Paris, he was almost fatally suffocated by gas and smoke from the fire brands which had been brought in to warm his chamber. His successor, the Emperor Jovian, actually died, as stated by Ammianus Marcellinus, through suffocation from the charcoal fire in his bedroom.

"The principal advance in heating during the Middle Ages came through the introduction of chimneys into private dwellings. For many centuries

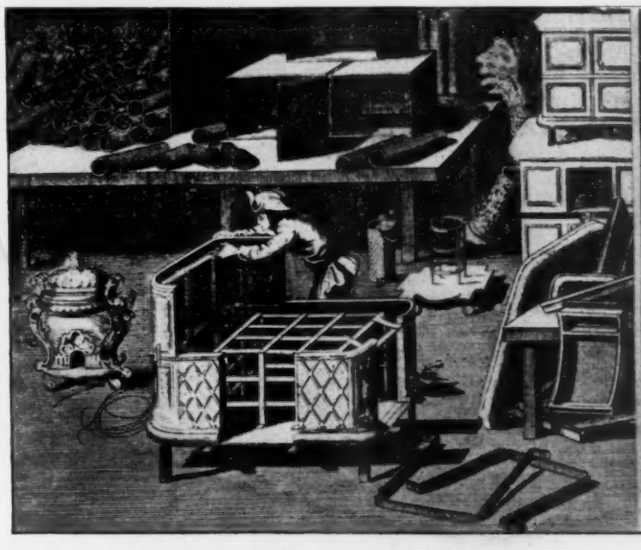


FIG. 18—ASSEMBLING STOVES IN A FRENCH FACTORY IN 1780

FIG. 19—ANOTHER VIEW OF A FRENCH STOVE PLANT IN 1780

the fire had been merely piled up in the middle of the room or burned in a brazier. The first chimneys for private dwellings seem to have been introduced in France in the eighth century, but they were rare and did not become common for several hundred years. Some of the oldest relics of chimneys show them as a drawing-out and tapering of the whole roof of the kitchen, which was detached from the rest of the mansion.

"The earliest fireplaces were without a grate, and the flue, instead of leading into a chimney, simply narrowed to a small slit which was carried out of the side of the wall not far above the fireplace. Several notices of chimneys are to be found in England in the twelfth century, and a description of the earthquake at Venice in 1347 A.D. mentions that it hurled down many chimneys. But in Rome in 1368 the Lord of Padua found no chimney at the palatial inn where he sojourned, and bringing workmen from Padua, had one constructed and decorated with his arms.

The Early Use of Coal

"In Poland and adjacent countries during the early Modern period the heating of the house during the long winter months was done by a kiln which was built into the room, but fired from the outside. The family slept not only around the sides, but on top of the kiln. The fuel in Europe had hitherto been almost entirely wood or charcoal, although coal had already been burned in China. The Saxons knew of coal, but rarely used it. In 1239, however, a charter of Henry III permitted coal to be dug at Newcastle, and although seriously objected to on account of its fumes, coal gradually came into use.

"Although the fireplace is still more or less imitated for its decorative effect, it was far from a thing of comfort. Placed at one end of the hall, the draft was such that a person standing in front of the fireplace would almost freeze on one side while he was scorching on the other. Sudden drafts down the chimney often drove the smoke through the room and deposited soot over everything.

"One of the first steps from the fireplace toward the present-day stove was to connect a tile oven with the chimney. Such an oven seems to have been invented in Switzerland in the ninth century. It was introduced into north Germany, and later carried to America by the Dutch. In one form it had openings into it from the fireplace and was also heated by hot coals being placed in it and afterwards withdrawn.

"Another device was the square German box stove, which was built against the chimney and opened into it. It was often built at the intersection of the inside walls so as to heat several rooms at once. Box stoves were later made of iron, and it is said that plates were cast for the purpose as early as 1509 in Ilsenberg. Cooking hearths with metal plates were made by Cardano in 1550.

Early Modern Improvements

"At the beginning of the seventeenth century investigators began to realize that the fireplace sent most of its fuel and heat up the chimney, and various attempts were made to remedy this defect. A fireplace in the Louvre in 1624 was built with air passages at the side. Cardinal Polignac, in 1723, put flues both at the sides and back, but his idea was cried down by people who objected to breathing 'air that had passed through red hot pipes.'

"Metal jamb stoves, which were built through the chimney so as to warm the room opposite the fireplace, were made in the Colonies as early as 1730 to 1740, by Christopher Sower, of Germantown, Pa. At this period the churches were heated only by foot warmers, which were small, covered sheet iron pans, about 6 inches square, filled with live coals. In 1744 Benjamin Franklin constructed what he called the Pennsylvania fireplace. In this a box stove was set to a greater or less distance toward the center of the room. The smoke passed through a flue down the back of the stove and through another flue in the floor to the chimney. The great advantage of this arrangement was that it gave forth heat from all sides at once. It needed little more than the invention of sheet iron stove pipe, about 1750, which could be run up through the room, to make it correspond rather closely to a modern sheet iron box stove. Hot air heating, which had been used in a few isolated places during the Middle Ages, was in 1750, applied anew in St. Petersburg, where it was seen by Frederick the Great and a few years later adopted by him at Potsdam. Another appliance of Colonial days was the tin oven, a box-shaped affair placed close to the fire, designed for cooking by radiation.

"Troy, New York, seems to have become identified with the stove business in 1786, when box stove castings were ordered made in Philadelphia and shipped to Troy to be put together. The famous American tory, Benjamin Rumford, the discoverer of latent heat, suggested in 1796 the warming of rooms by means of the chimney, out of which notion the idea of the radiator in part developed. Anthracite coal, which had long been considered mere stone, seems to have been first burned successfully, with the aid of a grate, by Joseph Smith, in 1812.

Preventing the Cupola Bottom from Cutting Through

By W. J. Keep

Question:—After our heat is about half off, the cupola bottom cuts through and we would like to know how this can be obviated.

Answer:—If this occurs frequently, it may be well to investigate and to ascertain if it is to the advantage of anyone on the melting force to have such an accident occur. I know of one case where a melter had been discharged and another employe who had worked with him thought he could scheme to get the melter back by showing that no one else was able to take off as good heats as the melter. In this case, after the cupola was filled and while the melting force was eating lunch, one of the men poured a bucket of water along the side of the lining from the charging platform and it soaked into the sand bottom. When the hot iron came in contact with the wet bottom a large amount of steam was generated and the iron flowed into the blister raised in the sand and chilled against the bottom doors. Later this iron melted and flowed through the bottom. Furthermore, if all pieces of coke and slag have not been riddled out of the sand, these may be burned out later, leaving a weak spot in the bottom. Also, care should be exercised in laying the kindling, if wood is used to light the fire, as a piece may lie in such a position that when coke is thrown in, or when the iron is charged, the wood is forced partly through the sand bottom.

When iron begins to run through the bottom, a ball of tempered fireclay should be placed on the end of a plank which should be supported on a fulcrum and men at the other end of the plank can depress it to force the clay against the stream of metal. When the flow has been stopped, the plank should be held in this position until the heat is over.

It is dangerous practice to throw water on a hot bottom. Generally, such a cure will burn a good-sized hole in the bottom door and may crack it immediately. If the iron works through a second time, the cupola should be drained and the bottom dropped. Great care should be exercised in making the sand bottom to eliminate soft spots or openings around the junction between the sand bottom and the side wall of the cupola.

The Preparation and Use of Rapid Nickel Baths

The Use of Higher Current Densities Has Saved the Day for Nickel Plating — Some Companies Have Already Substituted Cobalt

By E P Later

THE insistent demand of business men today is for more production at increasing efficiency, which means turning out more work in a given time with substantially the same labor and equipment; in short, speeding-up manufacturing processes in every legitimate way. In response to this need the energies of investigators and workers in every line of industry are devoted largely to seeking the solution of the problems which are thus presented and as a result of all of this work new processes and new and better ways of accomplishing desired ends, are being discovered constantly. In metal finishing, remarkable progress has been made in several lines during the past few years, in consequence of which it is now possible to work under conditions that were absolutely unknown a comparatively short time ago.

Recently considerable interest was aroused among platers by the results which Kalmus and his co-workers obtained from their investigations of cobalt. Among other things, they found it entirely feasible to deposit this metal at a current density of 150 amperes per square foot, and even higher, thereby obtaining a coating of satisfactory weight and appearance in about three minutes. This was such a departure from the usual practice of nickel plating for an hour or so at a few amperes per square foot, that it is not surprising that the question of substituting cobalt for nickel in finishing received serious consideration by many companies and eventually was adopted by some. Cobalt resembles nickel in many ways and in numerous instances its substitution could be made without difficulty.

It must not be assumed, however, that no progress had been made in operating nickel baths at rates higher than the low minimum which prevailed for many years. A few years ago, prepared salts for producing rapid nickel plating baths made their appearance on the market and attracted some favorable attention, inasmuch as they really did permit of working at appreciably higher rates than were possible with the ordinary solutions. Analysis soon showed, however, that they were merely mixtures capable of giving considerably more concentrated solutions than those heretofore employed and with some of the knowledge obtained in this way, platers began to make their own rapid plating baths. As a result of the impetus thus given to the subject of rapid plating the current densities used were increased in some cases to several times their former values and the first steps were taken in the speeding-up of this operation.

Recently Dr. Watts has investigated the possibilities of plating nickel at current densities much higher than those ordinarily employed and has saved the day for nickel by proving that satisfactory deposits can be obtained at what we are accustomed to consider extremely high densities, in fact, equaling those which were found practicable in the use of cobalt. This means, of course, that more parts can be finished in a day's run, since the time required to turn out a tank load is reduced so much, thereby increasing the capacity with little or no expense for additional equipment or labor.

High Current Densities

Readers of THE FOUNDRY who are familiar with the work which was done on cobalt plating solutions will recall that those which operated satisfactorily at such astonishingly high current densities were highly concentrated, that is, contained a large amount of metal per unit of volume, and it is a well-known fact that, in a general way, the more metal a solution contains the higher is the allowable current density. On this basis alone it is apparent that it should be possible to obtain the same results with nickel baths, since the salts of this metal are about as soluble as those of cobalt. In certain other respects, however, nickel does not lend itself quite so readily to plating.

In the first place, it exhibits a strong tendency to go into what is known as the passive state, when subjected to certain conditions. In this condition nickel is not so readily attacked by acids; therefore, the corrosion of passive anodes is defective and part of the current is wasted in the production of acid, instead of taking metal from the anode and putting it into the solution. The efficiency of the deposition of course, is impaired under such conditions and the results are rather unsatisfactory all around. Furthermore, the presence of this excess of acid causes the evolution of a good deal of hydrogen at the cathode, where some of it is absorbed by the nickel deposit, making the latter hard and brittle and thus increasing the tendency to peel and break away from the surface of the plated parts. The addition of a small amount of some chloride such as nickel, magnesium, or sodium, may be made, although the latter is less satisfactory in some respects than the other two. This is perhaps the simplest and most effective way of combatting trouble of this sort.

Before describing the work which was done, a better understanding of the results obtained, and for that matter, of the mechanism of the whole process, may be had if we consider for a moment some of the properties of solutions and the effects thereon of variations in temperature and concentration, as a knowledge of some of these facts enables us to explain phenomena which otherwise might be puzzling.

Every student of science is familiar with the fact that pure water does not conduct electricity to any extent; consequently, when a plating, or other aqueous solution, allows a current to pass through it, it is evident that it is the dissolved substance or substances rather than the water which is carrying the current. Not all substances when dissolved in water, however, will conduct a current; certain ones such as sugar, and many others, do not have this power, so we are accustomed to distinguish those whose solution is capable of carrying a current, by the term electrolyte. Acids, bases, salts of the metals, and so on, belong in this class. Substances whose water solutions are not conducting are known as non-electrolytes. It is clear from this that there must be some decided difference in the nature of the substances belonging to these two classes; or, what amounts to the same thing, there must be certain fundamental differences in their solutions.

As the result of considerable experiment and study it has been concluded that soluble and non-electrolytes dissolve in water without undergoing changes; in other words, there is no breaking down of the molecule. Electrolytes when in solution, on the other hand, are considered to be resolved into great numbers of exceedingly small parts, of two different kinds; one of these parts is the positive, or metallic, constituent of the salt or other sub-

stance and bears a positive charge of electricity, in consequence of which it will, under the influence of a current travel to the cathode or negative pole. The other part is the negative constituent of the molecule of the substance in solution; it bears a negative charge of electricity and, under the influence of a current, will travel to the anode or positive pole.

These tiny masses or particles, which are infinitely smaller than anything with which we are familiar in our everyday life, are called ions and are further distinguished as cations, or positive ions, and anions, or negative ions.

According to this view, when sodium chloride or nickel sulphate, for example, are dissolved in water they undergo a certain disintegration, breaking up into positive sodium or nickel ions and negative chlorine or sulphate ions, as the case might be. In the case of an acid, sulphuric, for instance, the water solution would contain positive hydrogen ions and negative sulphate ions.

These ions must not be confused with metallic nickel or sodium or hydrogen gas, on the one hand; or with chlorine gas or hydrochloric or sulphuric acids, on the other, inasmuch as there is comparatively little resemblance between them. For instance, nickel ions bear an electrical charge, as previously stated, and are green in color; metallic nickel, on the contrary, is electrically neutral and has a white, metallic luster.

How the Current is Carried

We conclude, therefore, that it is the ions which conduct or carry a current through a solution and it will then follow that the ability of a solution to conduct a current will depend on the number of ions present. It is apparent that if only a small amount of salt is dissolved in a certain quantity of water the number of ions present will be much smaller than if two or three times that amount of salt were put into solution; consequently, the conductivity will be low; or, in other words, the resistance will be high. The number of ions present in a solution is dependent not only upon the quantity of salt which has been dissolved, but also upon certain other factors as well. One of these is the proportion of salt which ionizes, since some salts break up into ions more readily or completely than others; this, in turn, is affected to a considerable extent by the temperature of the solution and the amount of salt present.

The temperature of the water, in a large measure, also determines the amount of salt which can be taken up or dissolved. With a few exceptions, of which sodium chloride is one, salts and other substances are appreciably more soluble in warm or hot water than in cold; therefore, by raising the temperature of a plating bath, for example, it is possible to get more salt to dissolve and thus make a more concentrated solution. Under these conditions more ions will be present, for the reasons stated.

One interesting property of ions is that they are in constant motion and do not stand still, as might be supposed. What causes this motion need not be discussed here, but it will suffice to say that they are constantly wandering around and, in consequence of the frequent collisions with each other, the path which they describe is a very tortuous one. As a result, there is a good deal of what might be called waste motion; so the ions do not move from one part of a tank to the other so very fast after all. If water is carefully poured into a solution of a salt, so as to avoid mixing the two liquids, diffusion is so slow that a long time will be required for the salt to become uniformly distributed throughout the whole.

Every plater has had unpleasant experiences along this line, in that a plating solution which is being worked hard may become so impoverished in the ions of the metal which is being deposited that burning and gassing occur; in such cases it is evident that the diffiusion of the ions from other parts of the bath, is not sufficiently rapid to keep up with their removal from the neighborhood of the cathode. It is for this reason that agitation, either mechanically or by air, permits the use of higher current densities; the concentration of the ions is kept fairly uniform throughout the tank and local impoverishing prevented.

The rate of migration or travel of the ions depends on the conditions and is largely determined by their concentration, the temperature of the solution and what is known as its viscosity. The influence of temperature can be appreciated when it is realized that more salt can be introduced into a warm or hot solution than into a cold one, thus allowing greater concentration. At the same time a higher temperature increases the mobility of the ions themselves and makes it easier for them to move around, by decreasing the viscosity of the solution. Clearly then, the need of agitating a hot bath would be less than in the case of one which was used cold.

How the Salts Break Up

To sum up the foregoing briefly, for the sake of greater clearness, all of the salts which the plater is interested in ionize, or break up into two kinds of infinitesimally small particles, when in solution; one kind of particles bears a positive charge of electricity and comprises the metallic constituent of the salt; the other kind of particles consist of the acid or negative constituent of the salt and bear a negative charge of electricity. These particles are known as ions. It is the ions which conduct the current, when the latter is passed through the solution, and in turn, those bearing a negative charge are impelled by the current to travel to the anode, the positively charged ions going to the cathode, and there give up their charges of electricity and appear at these poles either as acid at the anode or as the deposited coating of metal, on the cathode. The greater the number, or concentration, of the ions in a solution, the more current will it conduct; consequently, the more rapidly can the deposition of the metal ions be made to proceed. The concentration of the ions depends, among other things, on the temperature of the solution and the kind and amount of salt dissolved therein. According to this, we should expect that the use of hot, highly concentrated solutions would allow plating to be conducted very rapidly, and such has been found to be the case.

Experiments Recounted

Considering the experimental work which was conducted in the effort to find out just what could be done in the way of preparing such baths, a solution was made up containing 32 ounces of nickel sulphate, 3 ounces of nickel chloride and 3 ounces of boric acid per gallon, and good deposits were obtained with it when working under the following conditions: Forty-nine amperes per square foot at 77 degrees Fahr., 130 amperes per square foot at 77 degrees Fahr., 295 amperes per square foot at 153 degrees Fahr., 422 amperes per square foot at 160 degrees Fahr., and 890 amperes per square foot at 198 degrees Fahr. Of course the character, smoothness and so on, of a deposit must be taken into consideration when the merits of different baths are under discussion, inasmuch as it is well-known that deposits tend to become rougher as they increase in thickness.

Assuming the efficiency of deposition to be the same, the thickness of a deposit is proportional to the number of ampere hours per unit of surface. An ampere hour represents a current of one ampere flowing for one hour; 100 amperes flowing for 10 minutes, therefore, would represent about 17 ampere hours. At 100 per cent efficiency, 19.2 ampere hours are required to produce a nickel deposit 0.001 inch thick. A deposit half of this weight, that is, a ten-ampere-hour deposit, is considered to be satisfactory for many lines. In the tests cited, two of the deposits were well over 20 ampere hours and another was about 15; so it can be seen that they were comparatively heavy.

The difference in the character of

the deposit obtained from hot and from cold baths was plainly shown by the use of aluminum cathodes, from which the deposit, of course, could be easily removed and studied. Heavy coatings were given and it was found that in every case the hot solutions, 150 degrees Fahr. and over, gave a deposit which could be polished without peeling from the aluminum base and when finally removed they were found to be of satisfactory quality physically.

Deposits From Cold Solutions

Deposits obtained from cold solutions, 100 degrees Fahr., in nearly every instance peeled away from the cathodes while still immersed in the bath, and in those cases where this did not happen the deposit was torn during buffing. It is apparent, therefore, that there is nothing to justify any fear that a deposit obtained from a hot bath is not the equal of one obtained from a cold bath, as far as strength is concerned.

Nor does the current efficiency appear to be seriously lowered by the use of current densities of the magnitude employed in these experiments. It was determined, of course, by accurately measuring the current flow and the time and then ascertaining the weight of metal deposited. Comparing this amount with the quantity which should have been deposited according to theory, gives the per cent of cathode efficiency. Efficiencies of considerably over 90 per cent were obtained at current densities of 200 amperes per square foot and over.

There is such a difference between these figures and the 10 or 20 amperes per square foot ordinarily employed in nickel plating that the interesting question arises as to the factor which exerts the most influence in permitting the use of these very high densities. This point also was investigated and from some experimental work which was done it was concluded that the concentration of the solution is of greater importance than the temperature, although the latter plays an important part, as was shown previously. For instance, it was found that with a certain bath made up from the double nickel salt, two and one-half times the current that caused burning at ordinary temperatures could be used without any sign of trouble when the bath was heated to 158 degrees Fahr., the same weight of metal being deposited in both cases.

The question of anode corrosion is always an important one, inasmuch as unless this occurs at the proper rate the bath will become so impoverished in metal that plating is done at low efficiency and the results are unsatisfactory. Chlorine liberated at the anodes attacks them more readily than possibly any of the other acids; therefore, the use of a chloride, such as sodium chloride, has been common for a long time. Recently there has been more of a tendency to use nickel chloride to furnish the chlorine needed and this practice has at least one good point in its favor, in that while serving this purpose it also increases the concentration of nickel ions, which, of course, is an important item. The use of magnesium salts, either the sulphate or chloride, has also been common, in order to obtain the benefit of the well-known action of the salts of this metal in whitening the nickel deposit. The effect of sodium chloride on the deposit and on the operation of the bath has been studied carefully and in a preceding article it was stated that the sodium in this salt, under certain conditions exerts a decided darkening effect on the coating.

As the result of experiments on this point, the authors of the work under discussion found that nickel baths containing sodium chloride can not be operated at as high current densities as those which contain nickel chlorides. In view of this and the darkening effect which sodium chloride may exert on the nickel deposit, there would seem to be little to recommend its use; apparently it does nothing, as far as the operation of the bath is concerned, which can not be done just as well by some other salt, at the same time avoiding all possibility of trouble in other ways.

Hot Nickel Baths

Concentrated and hot nickel baths—160 degrees Fahr., seems to be about the right temperature—are in use in certain establishments and from what has been said, it is clear that they offer many advantages in the way of speeding-up the finishing of metal parts, inasmuch as it is possible to obtain in a few minutes the same weight of deposit that would ordinarily require an hour or so, when plating at the usual current density; platers who are still employing the solutions which have been in vogue for so many years would do well to investigate the possibility of replacing them by the others. In some cases it may not be possible or desirable to adopt the rapid plating bath for all of the nickel work, since experience has shown that the deposit, particularly in the deeper portions, is not always so white as that obtained from the cold bath and in some lines this would doubtless be a bar to their use. When the color of the deposit is not of so much importance this feature would not count and the question of whether rapid plating from hot baths should be practiced would have to be determined by the other conditions.

In conclusion it may be well to mention briefly one or two points which need watching in the operation of hot baths. One of these is the proper regulation of the acidity; hot baths quickly become alkaline in reaction, with the resultant production of dull deposits. Increasing the acidity of a nickel bath, within certain limits, of course, brightens the deposit, while an alkaline condition of the bath produces a dull or matt deposit, therefore, to obtain bright work from a hot solution requires more attention to this feature.

Furthermore, a hot bath must be operated at a high current density in order to work efficiently and this may mean that a heavier current will be drawn than the leads and conductors can handle without heating. Care must be taken, therefore, to see that the power plant and everything connected with it is able to withstand the demands which are made, otherwise part of what is gained in one way may be lost in another.

Census of the Brass, Bronze and Copper Industry

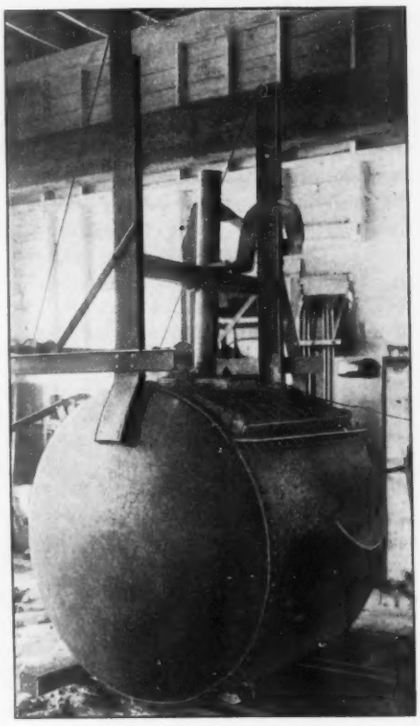
The bureau of the census of the department of commerce has just issued its report of the industry engaged in the manufacture of brass, bronze and copper products for 1914. Unfortunately this report does not cover the entire brass foundry industry as it does not include the manufacture of bells, hardware and plumbers' supplies. However the statistics relate to the manufacture of brass and bronze alloys, consisting chiefly of copper and zinc, copper and tin and copper and german silver products and aluminum castings. It shows a total of 992 establishments in existence in 1914 in which 45,657 persons were employed. The capital invested was $116,092,882 and the value of the products was $162,199,019. A marked tendency toward a shorter workday is shown by this report. In 1909 nearly one-fourth of the average number of wage earners was employed in establishments where the prevailing hours of labor were 60 or more per week, whereas only about one-sixth were so employed in 1914. On the other hand, the number of wage earners in establishments where the prevailing hours were fewer than 54 per week increased from 4.2 per cent in 1909 to 21.2 per cent in 1914.

Westinghouse, Church, Kerr & Co. have been retained by the Wright-Martin Aircraft Corp. to design and construct a large extension to its aluminum foundry at New Brunswick, N. J. Westinghouse, Church, Kerr & Co. also recently were retained by the Central Railroad of New Jersey to design and construct a boiler plant at the railroad's coaling station at Communipaw.

New Process of Electric Steel Melting

Many types of electric furnaces are being used by foundrymen for melting steel scrap on a small basis. The melting costs are said to be low, but there has always been a loss connected with the remelting of steel and a wildness during the process of pouring. The latter is claimed to be alleviated by a method patented by the Greene Process Metal Co., Seattle. It consists of covering the bath of steel with an acid slag. When carbon from the coke unites with the silicon contained in the slag, the result is the formation of silicon which aids in the deoxidation of the steel. Nearly all methods of deoxidation are accomplished by the same reactions, although they differ from the foregoing process in that the deoxidizing agent is in contact with the metal for a longer period of time.

When the furnace is equipped with an acid lining, an acid slag which contains silica as the essential component, is used; when equipped with a basic lining, a basic slag which contains lime as the essential component is employed. The process is applicable for melting either alloy steels, gray or malleable iron and brass or other metals. Reducing conditions in the furnace are maintained by continually forcing a reducing gas around the electrode. The purpose of this gas, since it is colder than the furnace chamber, is to keep the roof cool; to prolong the life of the lining; to protect the electrode and to maintain reducing conditions in the furnace.



GREENE ELECTRIC FURNACE OF ½-TON CAPACITY

In conjunction with the slag process, the Greene Process Metal Co. manufactures electric furnaces from 200 pounds to 10 tons capacity. The furnace shown in the accompanying illustration has a capacity of one-half ton and was built for the Aurora Foundry Co., Seattle. It is constructed of heavy boiler plate with the tap hole on one side and the lever-operated charging or slag door on the other. When pouring the molten steel, the vessel is tilted on standard rails, the tilting limit being governed by bumpers which are bolted to the side of the shell. The furnace is designed for single-phase current and consumes 200 kilowatts per hour at 110 volts. The electrode is clamped to a crossbar which travels up and down in vertical guideways riveted to the upper part of the bulged end plates. Two cables are clamped to this electrode support and after passing over sheaves at the top of each guideway, are securely fastened to separate drums which, in turn, are attached to a hand-operated geared shaft.

The 1918 Year Book of the Western Electric Co., New York, is an exceedingly comprehensive volume, consisting of 1160 pages and contains more than 50,000 items. It constitutes a handbook of electrical supplies. The uniform list price and basic discount inaugurated by the company three years ago is continued and, in addition, manufacturers' list prices are shown on certain standard lines for the convenience of those who prefer to buy on manufacturers' discount.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Metal Oxidized in Melting

Practically all of the brass castings that we are making are full of dross and contain ragged cavities over the entire surfaces of the machined objects. The mixture consists of scrap steam valves and engineering specialties and we use a flux to cleanse the metal.

The metal has been oxidized in melting and this may be remedied by placing a small amount of salt and borax in the bottom of the crucible before the metal is charged. When the pot has been filled with scrap add a ring on top made by cutting off the bottom of an old crucible. Fill this ring with scrap and charge charcoal or hard wood blocks on top of this. As soon as the metal becomes red, break the valves with a poker and continue to charge hopper until crucible is filled. Charcoal, to a depth of 1 inch, should be kept on top of the metal and the furnace should be forced until the metal reaches the proper temperature for pouring. Stir thoroughly and add the flux last, just before the metal is poured.

Coating for Ingot Molds

Bronze adhering to ingot molds causes us much trouble and results in their destruction in a very short time. How can this difficulty be overcome?

Apply a coating of plumbago mixed with kerosene to the ingot mold before casting and you will find that the metal will not adhere. The mixture should be of the consistency of paste and it is unnecessary to repeat coating the molds every time they are used, since one application will last for several heats. Too much of this mixture will darken the surface of the ingots and, therefore, it is advisable to rub it well into the iron.

Recovering Metal from Solder Sweepings

We produce about 5 tons of solder sweepings per month which we remelt into bars. The alloy consists of 10 parts tin and six parts lead, but it is more or less contaminated with iron filings and a small amount of aluminum filings and sand. The solder adheres to the iron and is almost impossible to separate. We would like to know how to refine these sweepings to recover all of the solder.

The most practical method of recovering the metal from the sweepings is to melt these fine particles in a furnace with an inclined hearth. The temperature should not be higher than is required to melt the solder. The metal will flow down the inclined hearth to a gutter and into a separately heated kettle from which it may be dipped

for casting into strips. The iron, aluminum and also the sand probably will be left on the sloping hearth of the furnace and may be removed from time to time. This residue, of course, will contain some solder, but it will be more economical to dispose of it to a smelter than to attempt to clean it with your facilities.

If a liquidating furnace is not available an effort should be made to remove the iron from the sweepings by the use of a magnetic separator. If such a machine is not available, the iron and aluminum might be removed by oxidation by the addition of litharge to the molten bath and after the dross has been skimmed off the solder should be purified by sinking small sticks of green wood into the bottom of the metal.

Preparing Car Brasses for Babbiting

Will you please favor us with directions for preparing the solder and for tinning railroad car brasses, preparatory to babbitting them?

In order to tin railroad car brasses it is necessary to bore or grind out the bearing to make it smooth, level and clean. The next step is to swab the face of the bearing with zinc chloride flux, after which it is tinned in a bath of half-and-half solder. The surplus solder is wiped off with a piece of waste and the bearing is clamped against a mandril and the space between the mandril and the face of the bearing is filled with molten, hard lead, an alloy of varying composition, but averaging around 85 per cent lead and 15 per cent antimony.

Would Make Fuse Bodies in Permanent Molds

We would like to cast fuse bodies in permanent molds and a metal is required that will have practically no shrinkage. We cannot use a brass mixture as this is unsatisfactory for this work.

There are no known alloys suitable for making fuse bodies which have no shrinkage. An alloy containing 50 per cent tin and 50 per cent zinc has a very low shrinkage and is well adapted for making white metal castings. However, this mixture is not suitable for the purpose mentioned. As a rule, fuse bodies are made of yellow brass, but since this alloy is not suitable for casting in permanent molds, it cannot be employed in this connection. However, we believe a 10 per cent aluminum bronze would cast satisfactorily in a permanent mold, but unfortunately it has a high percentage of shrinkage and, therefore, it would be difficult to produce castings free from shrinkage cavities. We believe that if attention is concentrated on means for overcoming their shrinkage, that success will crown your efforts. The shrinkage of aluminum bronze is increased by the addition of iron to the alloy and, therefore, the mixture should contain only copper and aluminum in the proportions of 90 per cent copper and 10 per cent aluminum.

Injecting Iron into Bronze Alloy

Kindly advise us the best method of inserting iron into a bronze alloy, or in other words alloying successfully a mixture of 90 per cent copper, 9 per cent aluminum, and 1 per cent iron.

The best way of getting the iron into this alloy is to use thin tin plate clippings. Melt the copper under charcoal, add the iron in loose bundles, stir well with an iron bar but do not make any especial attempt to get the iron to dissolve in the copper, simply see that it is pushed below the surface of the metal in order to avoid oxidation of the iron, after the tin is burned off. When the aluminum is added to the copper, the heat of the reaction will dissolve all the iron, and the latter will enter into solution without the least difficulty.

Trouble Caused by High Sulphur Content

We are having trouble in getting good castings from a mixture of copper, 90 per cent and tin, 10 per cent. The metal is melted in an oil-fired furnace without crucibles. We would appreciate any suggestions you may have to offer.

The trouble is probably due to porosity, which may be avoided by the following precautions: If the oil is high in sulphur, a flux of lime, charcoal and salt will materially assist in preventing the absorption of sulphur. It is advisable to add phosphorus to the copper, using about 0.25 per cent of the 15 per cent alloy of phosphorus and copper. This process will insure sound castings.

Porosity Troubles Make Cast Copper Rise in Heads

We have been trying to make copper castings but have met with considerable trouble from porosity. The copper, when poured sometimes rises gently in the heads and ultimately flows out onto the floor. This may happen with only one casting in a heat, while the other will lie quiet in the heads and be sound after machining. We are melting scrap copper in an 18-inch cupola, and the metal is very hot. We have trouble with shrinkage in the castings and wish to know if this can be avoided. Also what effect does silicon have when added to copper?

The difficulty is due to oxidation of the copper by the blast, and to absorption of sulphur from the coke. When the castings are poured, the sulphur and oxygen combine to form a gas known as sulphur dioxide, the expansion of which forces the copper back out of the sprues and risers, causing sponginess. The addition of silicon-copper to the copper will remove the oxygen and enable solid castings to be obtained. From 1 to 2 per cent of the 10 per cent silicon-copper should be added in the ladle and the copper should be very thoroughly stirred after the addition to get the silicon distributed uniformly throughout the copper; otherwise one casting may be good and the other spongy. The shrinkage of the castings must be provided for by the use of heavy risers which provide metal to soak back into the casting as the latter solidifies. The shrinkage cannot be prevented by any means that will enable a solid casting to be obtained and will have to be accounted for when the mold is made.

Metal Mixture to Resist Alum Solution

We would like to have a mixture for bushings that is to be subjected to the action of water containing 2 per cent of alum.

The following alloy will prove satisfactory for this service: Copper, 90 per cent and tin, 10 per cent. Melt the copper under charcoal and glass and when thoroughly molten, add the tin and stir well.

Pouring Temperatures of Copper Alloys

We would like to obtain the proper pouring temperatures for the following alloys:

No. 1.—Copper, 85 per cent; tin 5 per cent; zinc, 5 per cent; lead, 5 per cent.

No. 2.—Copper, 88 per cent; tin, 10 per cent, and zinc, 2 per cent.

No. 3.—Copper, 90 per cent and tin, 10 per cent.

The melting points of the three alloys, according to the researches of H. W. Gillett, of the Bureau of Mines, are as follows: Alloy No. 1 melts at 970 degrees Cent. (1780 degrees Fahr.); alloy No. 2 melts at 995 degrees Cent. (1825 degrees Fahr.), and alloy No. 3 melts at 1005 degrees Cent. (1840 degrees Fahr.). The proper pouring temperatures of these alloys will depend on the castings to be made. A heavy casting can be poured at a lower temperature than a thin one. This can be determined by experience. Experiments have determined that it is better to err on the side of too much heat than

too little. Generally the range of pouring temperature of a gun metal containing 88 per cent copper, over the melting point, will be from 100 to 140 degrees Fahr., the pouring temperature of the 88-10-2 being about 1965 degrees Fahr. The pouring temperature of the gun metal, copper, 90 per cent and tin, 10 per cent, will be around 2000 degrees Fahr., but all these figures are liable to variation according to the section of the casting. It is advisable to pour all castings before the metal becomes dull and sluggish regardless of a few degrees plus or minus shown by the pyrometer, as more castings are lost by dull-pouring than by hot-pouring. Therefore, it is better not to appoach too near the melting point of the alloy being poured into the molds.

Intercrystalline Shrinkage Causes Defects

We are experiencing difficulty in making an aluminum casting in the form of a box with walls ⅛ inch thick. A soft dry sand core is used and notwithstanding all precautions, the upper or cope side of the casting is full of pits.

This trouble is caused by intercrystalline shrinkage and the location of a heavy, built-up riser adjacent to the defective area will eliminate this defect. If the riser cannot be located as suggested, the casting must be molded in some other position which will permit the upper surfaces to be fed sufficiently to prevent this shrinkage. In the sample casting submitted, it will be noted that the raised letters are badly distorted as a result of the metal sinking away. If you exercise a little ingenuity in placing the risers to feed these defective areas and in conjunction with higher heads, we believe your difficulties will be remedied. Also, the aluminum contains impurities which add to the casting difficulties. It is possible that the addition of 5 per cent of zinc might also prove helpful.

Casting Tobin Bronze in Sand

Kindly let us know whether it would be advisable for us to attempt to make tobin bronze sand castings and if so, kindly indicate the proper course of procedure.

The alloy known as tobin bronze was devised by John H. Tobin, United States engineering corps, in 1875 or 1876. Its composition is stated to have been as follows: Copper, 58.22 per cent; tin, 2.30 per cent and zinc, 39.48 per cent.

Another analysis of tobin bronze gave copper, 57.55 per cent; tin, 1.49 per cent; zinc, 40.02 per cent; lead, 0.56 per cent and iron, 0.38 per cent. It will be noted that this alloy is similar to manganese bronze except that it contains neither manganese nor aluminum and if any of the latter metal is contained therein it is merely a trace. We cannot advise you with reference to the production of this alloy in your shop, but if you decide to proceed, the addition of 2 ounces of aluminum to each 100 pounds of the alloy will facilitate making these castings in sand.

Particles of Sand Mixed with Metals

The brass bushings we are making contain holes enclosing a gray substance which is so hard that it dulls the cutting tools. We purchase ingot metal containing approximately 82 per cent copper and 6 per cent each of zinc, tin and lead. The metal is melted in crucibles with natural gas for fuel and the use of glass as a cover does not reduce this defect. A small amount of phosphorus is thrown on top of the metal which is thoroughly stirred and skimmed before pouring.

The gray colored substance is sand, either from the mold or core. If the core leaves a smooth surface on the casting, the dirt does not come from the core, but from the mold. On the other hand, if the opening is rough, coat the core with a plumbago wash, using molasses as a binder. The defects on the cope side of the casting appear to be due largely to the sand of the mold, the metal having cut the gates and washed the sand into the casting. The remedy is to use a more open, tougher sand and to work it wetter than is being done. Use a set gate, that is, a gate molded with the pattern and in place of the broad, flat gate now being employed, use an oval gate, about ¾ x ½ inch. The black spots are due to dross in the metal which contains more iron than it should. We suggest that an analysis be made to determine the percentage of iron, as this element increases the casting difficulties. The addition of 0.25 per cent phosphor copper might improve the fluidity of the alloy and will help to get cleaner castings.

Difficulties in Making Brass Bushings

We are experiencing difficulty in making brass bushings. The castings fail to come clean, although we have tried various methods of gating. We are melting the metal in an oil-fired crucible furnace. Kindly give us a mixture for bushings and also a flux for alloying lead and copper in the proportions of half and half.

If all scrap is being used in the bushings, probably the metal is at fault. Mixtures of scrap metals will not always produce clean alloys because they contain silicon and aluminum. Such metal is unfitted for brass foundry purposes. This point can be determined easily by making a few bushings of a mixture consisting of copper, 80 per cent; tin, 10 per cent and lead, 10 per cent. This mixture should make clean castings, particularly if the bushings are small. If you want to use a flux, plaster of paris and salt is good for this purpose. Always use charcoal in melting, but if it will not stay on top of the crucible in the oil-fired furnace, use fine hard coal. It is necessary to keep the surface of the metal covered while melting. A little phosphor copper, about 0.25 per cent, would be a good addition to the alloy, whether scrap or new metal. A flux used extensively in making 50 per cent lead and 50 per cent copper alloys is galena, a native sulphide of lead. Roll sulphur also is used as well as many other substances that give satisfaction.

A Soft Core and Better Melting Will Prevent Cracking

We are making brass castings that develop cracks when they are machined and our losses are unusually heavy as a result of this defect. We melt the metal in a crucible, oil-fired furnace, the mixture consisting of borings of unknown zinc content, copper and red brass scrap. Considerable manganese bronze is mixed with the metal and this adds aluminum which undoubtedly causes cracking, although the castings sometimes crack when aluminum free.

Since the castings you are making are circular, it is probable that the cracking may be controlled by using a softer core. If the core is green sand, cut out the center with a sprue cutter, leaving only a thin wall of sand that will yield readily as the metal contracts. If dry sand cores are employed, make them as soft as possible to reduce to the minimum the resistance to the contracting metal. The metal of the casting which you forwarded, is badly oxidized. Also, it is inherently weak and this coupled with the oxidation, makes it excessively red-short. As a result, the metal is unusually weak when passing from the liquid or pasty to that of the solid state and the slightest resistance at this point has a tendency to break the casting. This weakness does not exist uniformly throughout the thickness of the casting, however. The inner and outer surfaces of the casting, where the metal has been chilled by the sand, are stronger than the metal inside the casting. Instead of cracking, these surfaces stretch, but the inside metal ruptures and when the outer surfaces are machined, the inside cracks are revealed.

To overcome this difficulty, a soft core should be used and the metal

should be strengthened as much as possible by avoiding oxidation during the melting process. In the operation of an oil-fired furnace, glass and powdered coal should be used as the covering for the metal in place of charcoal. Inasmuch as the use of scrap is unavoidable, melt the solid metals first and when hot, shut off the oil and swab off the flux enough to permit of the addition of a sufficient amount of borings to cool the metal. Cover the surface again to raise the metal to its high temperature, then add more borings and continue this practice until the addition of borings is completed. The introduction of about 4 ounces of phosphor copper would be advisable just before pouring.

Strengthening German Silver

We are making German silver castings using the 18 per cent alloy, but we find that this is too soft for our purpose. We would like to know how this metal may be strengthened.

German silver can be stiffened by the addition of iron, tin or aluminum. For ordinary casting purposes, aluminum probably will prove to be satisfactory. The proper amount to use must be determined by experiment as the degree of strength required is known only to the party making the inquiry. We suggest that you begin with the addition of 0.25 per cent iron and this may be increased according to requirements. If the castings must withstand pressure, aluminum is not a desirable addition and we suggest a trial of the following alloy: Copper, 61 per cent; nickel, 18 per cent; zinc, 20 per cent, and tin plate clippings, 1 per cent. Melt the copper and nickel together under charcoal, or under a cover of fluorspar and lime, and while the metal is being melted, avoid all unnecessary stirring. When the metal is melted and is still hot, add the tin plate loosely coiled and when dissolved, add the zinc in the usual way. A small amount of manganese can be used as a deoxidizer.

How to Make Manganese Bronze

We have been unable to make manganese bronze with a tensile strength of 60,000 pounds per square inch. In melting, the copper first is made molten, after which the manganese copper is added, followed by the aluminum, tin and spelter in the order named. Some of our heats produced a metal that is quite brittle, the fracture being crystalline.

The following method for making manganese bronze is generally pursued: Make a steel alloy by melting together 18 pounds of wrought iron and 4 pounds of ferromanganese to which 10 pounds of tin are added. This alloy is cast into thin ingots. To make the manganese bronze, melt 50 pounds of copper and when molten add 2½ pounds of the steel alloy. Care should be exercised to insure the solution of the steel alloy with the copper after which 6 pounds of copper are added to cool the mixture, followed by the gradual addition of 24 pounds of zinc. Throughout this operation the metal should be stirred constantly. To produce an alloy that will run well the addition of aluminum is essential and this should be added just before the zinc is introduced. The amount of aluminum used varies in different shops from 0.10 to 2 per cent and over. As a rule, however, 0.5 per cent is ample and this gives better results than the smaller additions. The alloys in which higher percentages of aluminum are used are supposed to shrink more than the low aluminum alloys. However, it is doubtful if this affects the manganese bronze in this way and recently many foundrymen have reduced the aluminum content to 0.10 per cent.

The alloy at first should be cast into ingots and then should be remelted for making castings. When the metal is brittle and the fracture crystalline, it is evident that the alloy contains too much zinc or aluminum, or possibly both. Aluminum and zinc in manganese bronze act similarly, but aluminum being the most powerful, with an accompanying high zinc content, should be less than 1 per cent. On the other hand, when the aluminum content is high, the zinc addition should be proportionately low.

The use of electrolytic copper for making the bronze is satisfactory. Manganese bronze with a tensile strength up to 80,000 pounds per square inch and an elongation of from 30 to 40 per cent now is being made by the use of spelter containing as high as 1.5 per cent of lead. To make manganese bronze successfully requires much patience and considerable experience.

Wanted--A Competent Superintendent

By W J Keep

LONG employment on one job speaks well for a man. The tendency now is to look for technically educated young men, but with rare exceptions they are not found in foundries. They often apply for positions in casting plants, but are not willing to accept the moderate wages offered after spending so much time in school. Also, the risk is great, both for the young man and for the proprietor. After he attains an executive position, it may develop that he lacks tact, or he may conclude that the business is too commonplace for an educated man. As a rule, molders look with suspicion on such a man and will object to any improvement suggested by him. In some cases such men have advanced to the top in foundry management and have made excellent superintendents. As a rule, however, foremen and foundry superintendents have been advanced from the molders' floor. Unfortunately, there are not as many well trained and intelligent molders as formerly, because labor is scarce and molding machines make it possible for an inferior man to make good castings.

A foreman, well qualified for the position, will see to it that the molders have facilities that will enable them to make good wages and good castings.

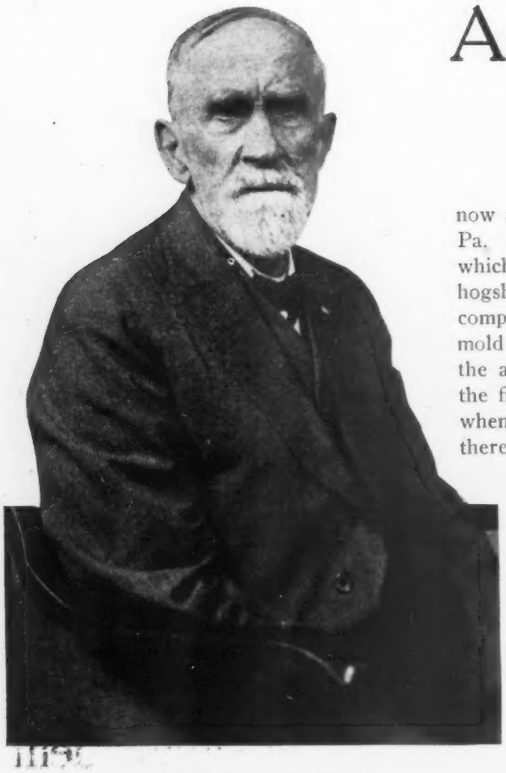
A foreman advanced from the floor will have a hard time learning to melt good iron and to understand the influence of the constituents of iron on the casting. He has not been accustomed to study and is in danger of objecting to what seems to him as theory. Often the routine of the shop is so great that he does not have time to concentrate. For example, when a new pattern is received, he uses poor judgment in selecting the molder to make it and does not notice that the piece is lost, day after day. By having a slight change made in the pattern or by giving it to another molder, the castings could be saved. By looking into the matter it will be found that the rigs are defective, or that proper facilities are not provided, and that the makeshifts resorted to by the molder have caused the losses.

A foreman of any plant should be able to do every part of the work better than any mechanic in the shop. He is then competent to select and train a man to assume his duties if he is elevated to a higher position.

The Davis-Bournonville Co., Jersey City, N. J., recently has opened a government sales office in the Colorado building, Washington, with Henry R. Swartley Jr., resident manager. The company manufactures oxy-acetylene welding and cutting apapparatus and oxygen and hydrogen producing apparatus, which is being used extensively by the army and navy

Active in Industry at Age of 72

Long Industrial Career of Pioneer Foundryman Interrupted Only by Civil War



CHARLES L. TITTLE

Identified with the foundry business continuously for over 50 years. Now operates a jobbing shop at Blairsville, Pa., employing 30 men and having a daily capacity of 10 tons

WHEN he was 16 years of age, Charles L. Tittle concluded that he wanted to become a foundryman. Today, at the age of 72, Mr. Tittle, virile and young in spirit, owns and is actively in charge of a foundry at Blairsville, Pa. In point of active service, he is believed to be the oldest founder in the United States. Except for the time he served in the union army, Mr. Tittle has been connected with the foundry business continuously since his first day of apprenticeship. During the some 52 years that he has been making castings, he has seen the industry grow from its infancy to its present highly important state. He became a foundry operator on Nov. 25, 1877, when he purchased a small plant at Blairsville, which he has developed and operated ever since. His experience has been a varied and most interesting one. Mr. Tittle learned the trade at the plant of the old Cambria Iron Co., at Johnstown, Pa., where he was born on Oct. 18, 1845. A boy of only 16 years of age, he took up his apprenticeship with the old Cambria company in 1861. After working there three years, he joined the army at Johnstown as a private in the 194th regiment, Co. F, Pennsylvania infantry, under Capt. W. R. Jones. This was in 1864. The name of Capt. Jones is well known to the trade, as he built the Edgar Thomson Steel Works in 1874, now a part of the Carnegie Steel Co. In 1862 Mr. Tittle was one of the men who helped to get hot metal to the converter to blow steel at the foundry of the old Cambria plant. This was during the period of experimentation. This converter is now a cherished relic in the main office of the Cambria Steel Co., at Johnstown, Pa. According to Mr. Tittle, William Kelly obtained a patent on this converter, which now bears Bessemer's name. This converter is about the size of a hogshead. The first actual heat of bessemer steel was made by the old Cambria company on July 10, 1871. Mr. Tittle made the mold for casting the first ingot mold bottoms used in pouring the steel, for making ingots. This was previous to the actual blowing of the steel for which he helped carry the molten iron for the first heat blown. Mr. Tittle remained with the Cambria Iron Co. until 1867, when he went to Knoxville, Tenn., and worked about six months, going from there to St. Louis, where he worked three months. In 1868 he returned to Johnstown and worked for the Cambria Iron Co. until 1875, when he went to Braddock, Pa., where Capt. Jones was about ready to blow steel at the Edgar Thomson works. Mr. Tittle was employed there as foreman in preparing the bottoms of the molds in which the steel was poured. In 1876, he went to Indiana, Pa., becoming foreman of the old McFarland foundry, which did general stove and agricultural work, and is now known as the Penn Enameling Co. His next move was the purchase of the little foundry at Blairsville from Samuel Ray, which at that time made plow points and stove repairs. This was on Nov. 25, 1877. The foundry was a frame building, 24 x 40 feet. Mr. Tittle and a boy did all the work. In the third year the new owner had completed his payments on his plant. It was at this time that the apprentice boy who had been disgruntled because he had been discharged, became too intimate with the cup of trouble. He went to the foundry and set fire to it. It was completely destroyed. This was indeed most discouraging to the new owner. However, he pluckily determined to start up again and was given assurance by Mr. Ray that the latter would do all he could to help him out. Thus encouraged, Mr. Tittle went to customers for whom he had orders for castings and asked for and was given more time to fill their contracts. It was only thirty days from the day of the destruction of the old plant until Mr. Tittle made the first heat in the new plant which he built, a frame structure 30 x 70

CAMBRIA'S FIRST CONVERTER

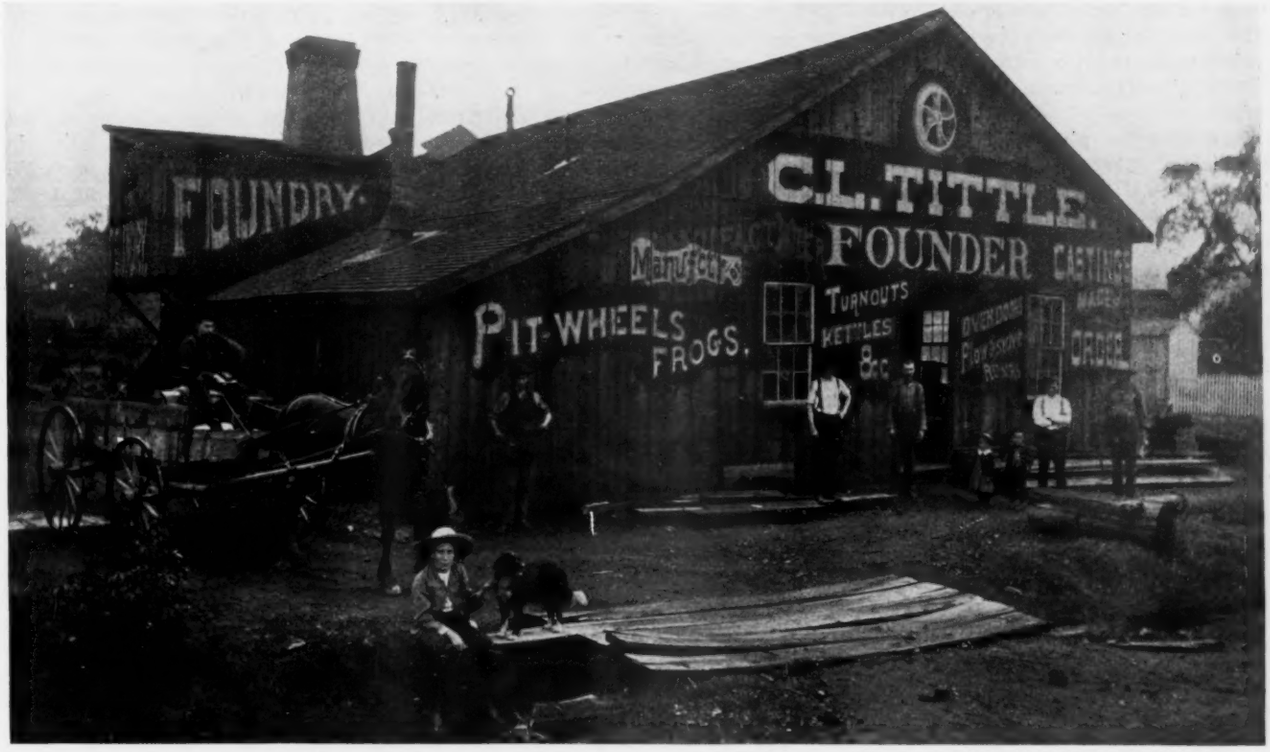
Pioneer converter of America, patented by William Kelly. The converter, mounted as shown above, is now a highly prized relic in the offices of the **Cambria Steel Co., Johnstown, Pa.**

feet. It was equipped with an old-fashioned engine, blower and cupola, the latter being made out of the shell of an old boiler which had been lined.

The plant at that time had a capacity of 1½ tons of castings each week and the working force consisted of Mr. Tittle and a boy. Fifteen years later a machine shop, 30 x 75 feet, was added. Business increased and it was necessary to erect an addition, a frame building, 40 x 75 feet, alongside the old one. These two buildings today make up the foundry plant of Mr. Tittle. The old plant has a 1½-ton traveling crane. The newer building was constructed about 12 years ago and is equipped with two jib cranes, one with a capacity of 5 tons and the other of 2½ tons. Business for the machine shop did not thrive as much as was expected and in consequence this part of the plant was abandoned six years ago. In April, 1897, Mr. Tittle bought the foundry and machine shop of Julius Wild, in Johnstown. After operating this plant for four years, Mr. Tittle disposed of it.

Today the foundry plant of Mr. Tittle has an average daily output of 10 tons of castings and employs from 30 to 35 men, of whom 12 are molders. Castings are made for steel, plate glass and brick works and coal mines.

Mr. Tittle has been an active member of both the American Foundrymen's association and the Pittsburgh Foundrymen's association since their organization.



OLD SECTION OF MR. TITTLE'S FOUNDRY, BUILT LATE IN 1877. MR. TITTLE STANDS IMMEDIATELY IN FRONT OF THE DOOR. THE PHOTOGRAPH REPRODUCED ABOVE WAS TAKEN IN 1882

Ascertaining the Compressed Air Consumption

By Harry H. Barclay

One of the perplexing problems for foundrymen to solve accurately is involved in ascertaining the amount of compressed air used by air-driven machines. From indicator cards the cost of all of the air used can be determined readily, but to ascertain the actual cost on each seperate casting or job is not so easy of accomplishment. Sometimes it is desirable to ascertain how many cubic feet of air are used in certain operations. Unfortunately, the tables compiled by authorities on the amount of air that will flow through an opening of a certain size in a given length of time, not always are applicable to existing conditions in casting plants.

Desiring to secure information regarding the amount of compressed air required per mold by different sizes of foundry vibrators, we proceeded as follows:

A small air compressor was used with a shut-off valve located between the compressor and the tank and in the latter the air pressure was raised to 90 pounds. The valve was closed and with a stop watch the time was noted that elapsed for the vibrator to reduce the pressure to 70 pounds. It may be assumed that for all practical purposes this would be equivalent to 80 pounds mean effective pressure, the amount in most general use in foundries. To illustrate in even figures, it will be assumed that the tank holds exactly 10 cubic feet of air and that it takes the vibrator exactly two minutes to reduce the pressure from 90 to 70 pounds. Therefore we figure that the vibrator used 10 cubic feet of air in two minutes. By actual tests it has been found that the average time the vibrator is working while the molder is drawing a pattern is about 15 seconds and, therefore, we get eight molds with 10 feet of air and the vibrator uses 1¼ feet of air per mold. This same principle may be applied to any air-driven tool or molding machine and we believe that the results are more nearly representative of actual conditions than theoretical calculations.

Zinc Refined by Distillation

A large amount of zinc is now being refined by distillation. This process removes the lead and the iron. By this method it is possible to reduce the lead to 0.05 per cent and the iron to 0.01 per cent. However, the cadmium in the unrefined zinc also will be found in the refined product. As the cadmium is volatile, it is not removed by distillation. For many purposes cadmium may be ignored, but it is claimed by some that it is undesirable in cartridge brass, as it makes the metal hard and brittle, and causes excessive scrap losses.

Correct Way of Making an Engine Piston Pattern

Much Time Can Be Saved or Wasted in Molding, Depending on the Manner in Which Patterns Primarily Are Constructed

By Frank B Raebig

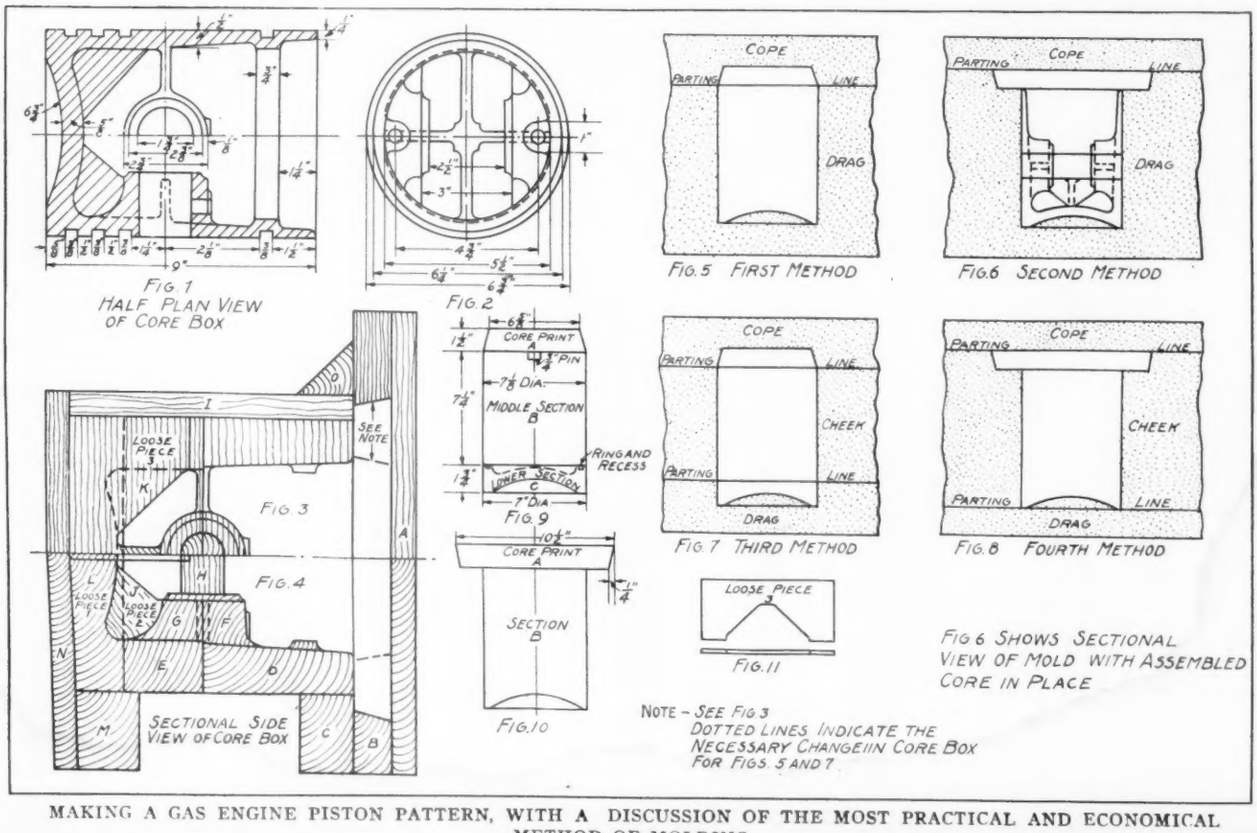
THE production of a gas engine piston pattern has been selected for this discussion because of the many interesting features that the work involves. One of the most important problems that a patternmaker must consider when he has a pattern to make is the method of molding it. Much time can be saved or wasted in the foundry, depending upon the way the pattern is constructed. Therefore, it behooves every patternmaker to construct a pattern so that it will produce the most economical results.

In Fig. 1 the piston is shown after machining. There are numerous ways by which this particular pattern may be molded, but to insure a good, clean casting it is necessary to mold it on end. Therefore, this discussion will be confined to four methods which will necessitate molding on end.

By the four different methods of molding this pattern there are only slight differences necessary in the construction of the model. For the first, second and fourth methods, Figs. 5, 6 and 8, the pattern consists of a core print and a cylinder, 7¼ x 9 inches, with one end concaved. For the third method, Fig. 7, it consists of a core print and a cylinder made in two sections, as indicated also in Fig. 9. For the first and third and second and fourth methods, the core prints are the same, respectively. This can readily be seen by referring to Figs. 5 and 7 and Figs. 6 and 8. For the first and third methods the core prints are dowelled to the pattern and are molded in the cope. By the second and fourth methods they are fastened permanently with screws and are molded in the drag and cheek respectively. By the first and third methods the core prints are made as large as the cope diameter of the pattern to form the round edge on the inside of the piston. This, I believe, is sufficient explanation for the first, second and fourth methods, but the construction of the pattern for the third method requires a little further discussion. By reference to Fig. 9, it will be noted that the pattern is composed of three pieces and that section *B* is a cylinder 7⅛ inches in diameter and 7¼ inches long; it has a ¾-inch dowell pin hole on one end and a ring which fits the recess of piece *C* on the other end. Section *B* is molded in the cheek. The piece *C* is a round disc, 7 inches in diameter and 1¾ inches long, and the inside is turned out to fit the lower end of the main core. It also has a recess to fit the ring of piece *B*, and on the other end it is concaved as indicated. This piece is molded in the drag. The reason that this is turned out as shown is to facilitate setting the core properly and to insure the uniform thickness of the metal.

The pattern for this piston is comparatively simple and easy to make, but the core box requires a little more skill and ingenuity. Figs. 3 and 4 show a half plan view and a sectional side view of the core box. The pieces used in its construction and the direction of the grain also are indicated. These two illustrations are not dimensioned, but are drawn to scale.

A piece of stock for pieces *E* and *D* should be dressed to the required dimensions. Then the semicircle should be laid out and cut on the band saw on the line, provided the saw is in good



MAKING A GAS ENGINE PISTON PATTERN, WITH A DISCUSSION OF THE MOST PRACTICAL AND ECONOMICAL METHOD OF MOLDING

condition. After this is done, smooth with a gouge and sandpaper. Next fit pieces *G* and *F* to *E* and *D*, respectively, allowing enough stock on these pieces to permit cutting the necessary fillets. After they are glued in place and dry, carve the fillets and sandpaper. Glue pieces *EG* and *FD* together. The grain of these pieces should run at right angles to the length of the core box to strengthen it. Then the ends of *EG* and *FG* are tapered about ⅛ inch to permit loose piece No. 1 to drop out of the box freely, when the box is removed from the core. Next fasten sides *I* to both ends of *EGFD* with glue and nails. Piece *B* should be cut to the required size and shape and fastened to the side of *D*. Next cut out and fasten piece *C* to the under side of *D* and *O* in the corner of *IB* and piece *M* under *E*. These three pieces are placed there to provide a strong and durable core box. Next the ends *A* and *N* are cut and screw holes are drilled in them, in order that they may easily be removed when the coremaker removes the core from the box. But before fastening *N*, this end of the box should be tapered ¼ inch so that loose piece No. 1 will drop out easily. The ring *P* then can be cut out and fastened in place. This completes the core box with the exception of the loose pieces which must be made. These form the end and three of the ribs which are located in the end of the piston.

Loose piece No. 1 is turned on the lathe and only one of the two pieces that are turned is used. Plane off the top of this piece 5/32 inch, or the thickness of one-half of the rib so that when loose end piece No. 3 rests on top of No. 1 it will be flush with the top of the core box. Piece No. 3 is shown in Fig. 11. It should be made either of cherry or mahogany to secure permanence. Piece No. 2 is cut as shown in Fig. 4 and is held in place with a loose pin. The fillets around these loose ribs are cut by the coremaker. Next, a core print, 1⅜ inches in diameter and 1¾ inches long, is turned with a ¼-inch pin and fastened on *DF*. This forms an opening in the main core for the insertion of a stock core, 1⅜ x 7 inches, when the two halves are pasted together.

This concludes the construction of the pattern and core box, and I now will discuss the four methods of molding this pattern and will point out which is the most economical. The first and second methods require a two-part flask and the third and fourth methods a three-part flask.

By the first method, Fig. 5, the core must be hung in the cope and secured. This is not good practice, only is permissible when it cannot be avoided. Therefore this is a disadvantage with no compensating advantages. By the second method, Figs. 5 and 6, the entire pattern is molded in the drag and a straight back cope only is necessary. By this method the hanging and securing of the cope are avoided, and only ordinary care is required to set the core. It is apparent that by this method a great saving of time is effected, although it has one disadvantage, and that is not serious. This disadvantage also is apparent by the first method. In setting the core by the second method and closing the mold in the first, sand may become dislodged and the molder is not aware of it until after the casting has been poured and it is then too late for correction.

By the third and fourth methods, Figs. 7 and 8, this particular disadvantage is overcome. After the core is set in place the molder can examine the mold carefully and can remove any sand that may have become dislodged. But these methods necessitate additional labor in molding and rolling-over which are not necessary by the first and second methods. If the losses by the first and second methods are greater than the necessary labor required by the third and fourth methods, then the latter two would be justifiable, but the reverse is true; therefore, it is safe to conclude that the third and fourth methods have serious disadvantages.

The third method has one feature which none of the others possess. This is the facility of setting the cores so that the metal is of equal thickness on all sides of the piston. A little further explanation of this method is necessary. After the mold has been rammed, the cope and the cheek lifted off, and the core print *A* and section *B*, Fig. 9, removed from the mold, the main core is placed in the opening of *C;* than the cheek and the cope are placed in their former positions and the core is secured in the cope and fastened. The drag is then lifted off and the lower section *C* is removed from the mold and the drag is again replaced and the mold is closed for pouring. If reduced time and labor were not of prime importance, this method might be practiced. Therefore, by a process of elimination we must discard the first, third and fourth methods which leave us the second as the most practical and economical.

Molding Slag Pots in Dry Sand

(*Continued from page* 11.)

The drag, shown in Fig. 2, is made in a brick-lined pit, which, with sweep in position, allows for sweeping approximately two inches of sand. Recesses are provided for the lugs or rests, cast on the outside of the pot, which are made in cores and set by sweep marks.

A space is also provided for laying the tile for bottom-pouring gate. A circular steel ring, fitted with movable guides, forms the top of the pit, and the bearing, or joint of the drag. This top plate is securely anchored to the plate in the bottom of the pit, as clearly shown in Fig. 2. The movable guides are set by a projection on the sweep, which is the radius of the steel ring used on the cope. The spindle, set in a seat in the bottom of pit, is centered and held rigid at the top by two angles, and is bolted to two columns forming the supports of the main bay of the foundry. Clay wash is then applied, and the sand is rammed and swept, after which the drag is finished and blacked. A coke salamander is suspended in the drag, and a cover, made for the drag, is applied. Drying takes place over night.

The only essential difference in the molding of the drags for the iron and steel pots is in the arrangement of the gates, and the facing sand used.

In gray iron practice, two rows of tile, layed one foot above the bottom of drag form the gates from the vertical tile or sprue. In steel practice, one row of tile 1 foot from the bottom of the drag, and one row, 4 feet above this, form the gates. In closing, the cope is rolled over on a pile of soft sand, about 4 feet high, and is covered with bags to protect the cope from moisture. The pots are held down with a sixarmed cast steel cross, 15 feet in diameter, having arms, 2 x 12-inch section.

A forged steel loop is slipped over each arm, and the opposite end, which is a toe, is hooked under the top plate of the pit. Steel wedges are then driven between the loops and the arms of the cross and the job is secured without the use of weights, against the enormous pressure encountered in castings of this class.

Bottom-pouring ladles are employed for casting both steel and iron pots, which require from 18,000 to 20,000 pounds of metal. Bessemer iron direct from the blast furnaces is used. The steel is of the same specifications as that used for the regular run of steel castings.

After casting, the iron pot is left undisturbed from one to two hours to allow for cooling and the burning of the wood strips, after which the cope is lifted, rolled over, and set up ready for another ramming. The steel pot is shaken-out as quickly as the wedges can be drawn and the steel cross removed. The barrel is lifted alternately at each lug to loosen it, and then it is lifted out entirely. Fifty of these steel pots were cast during 1916 without the loss of one and about 60 pots were cast in iron.

The rigging described has been in

use for a number of years in making iron pots, and the casting of steel pots was commenced two years ago. Three pots, either of steel or iron, can be cast per week, or one every other day.

The foregoing is from a paper presented by C. J. McMahon at the Boston convention of the American Foundrymen's association.

Iron Oxide in Molding Sand

(*Concluded from page* 5)

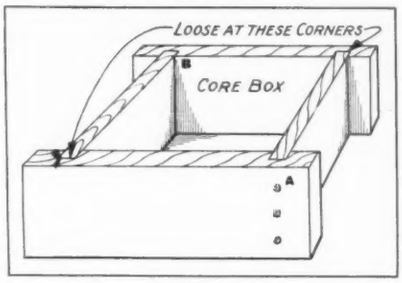
A further test was made by taking the same material as used in the mixture referred to above except that the iron and iron oxide had been removed from the fine dust from the dust collector by dissolving these out with hydrochloric acid, leaving the sand practically free from any iron content. This mixture, prepared in a sand muller, produced castings with a finish practically equal to that obtained by using fine molding sand as a facing.

I have seen clay added in the form of a wash for tempering and for restoring the bond in molding sand in mechanical handling systems and while this method may have merit for heavy work, it failed to produce the desired result for light castings. Nature seems to blend the silica and alumina, the principal elements in molding sand, better than we can do it by mechanical means. Alumina is the element that needs replacing, partly because it goes off in dust from handling the sand, but more, in many cases at least, to counteract the silica added in the form of core sand of which the chief element is silica. There may be equipment suitable for economically and satisfactorily blending the elements forming molding sand mechanically, and recent investigation indicates that this is true. However, even with a suitable means of reclaiming sand to the extent of restoring its bond by mechanically coating the silica grains with alumina, provision still must be made to take care of the iron oxide content.

Core Box Construction

As an apprentice in a pattern shop, I was instructed to make a core box in the following manner: Cut grooves in the sides to receive the ends; fasten the two corners, as at *A* and *B*, with glue, corner pieces and nails or screws; make the opposite corners loose in the grooves; but screw in the loose corners, when the core box is large and deep to hold the box together while the core is being made; when the core is finished, ease up these screws or take them out to allow the box to be drawn away from the core.

The fact that journeymen paternmakers employed in the shop were practicing this method of making cores and the fact that cores were invariably accepted by the core shop foreman, shows how widely accepted this operation had become. For this reason I continued to make cores in this same conventional manner for a good many years after my apprenticeship days had ended. Many patternmakers, just like men engaged in other lines of this and other industries, have probably thought of improvements over the accepted method of making core boxes. Sometimes they have revealed their ideas to men concerned in them,



METHOD OF MAKING A CORE BOX TAUGHT THE AUTHOR DURING HIS APPRENTICESHIP

but often fearing the criticisms of their foremen and fellow workmen, they have never allowed them to penetrate beyond the confines of their own minds.

When a patternmaker is employed alone he has a far better chance to exercise his inventive faculties. He is at liberty to visit the foundry and to consult with and watch the operations of the molders. If the patterns are not made right, the molder and the coremaker will be quick to tell him the troubles which they are experiencing.

It was not until I was placed in an environment of this kind that I discovered I could effect several improvements in the core box shown in the accompanying illustration. Of these, some of the most important were: Dress one side and also one edge of the boards on the jointer; saw the boards to the exact width on the rip saw; saw the end boards to the exact size of the core; glue and nail the four corners; secure with nails and glue large blocks of wood in these four corners and varnish the interior of the box if a great many cores are desired.

The word *exact* should be underlined, for by following instructions exactly, a good many hours of needless work can be eliminated. If the core box is to be 6 inches deep the lumber should be cut exactly 6 inches deep. The matter of leaving ⅛ or ¼ inch only entails additional work. If the core is to be 12 inches wide, the ends should be cut to that exact width on the band saw. When ends are made loose and screws inserted at the corners *A* and *B*, unnecessary labor is involved, for only rarely does the cokemaker touch these screws.

L. & A. ELECTRIC VIBRATOR OPERATED UNDER WATER

Operating an Electric Vibrator Submerged in Water

For the purpose of demonstrating that its device can be subjected to unusually severe treatment and can be operated under all kinds of trying conditions, the Pressed Steel Co., Muskegon, Mich., manufacturer of the L. & A. vibrator, has had one of these machines operating under water for a period of about two months. This experiment was undertaken for the purpose of demonstrating that the vibrator is not affected by dampness and that it is ample protection under all circumstances. In the accompanying illustration is shown the vibrator in a jar nearly filled with water and it will be noted that it is completely submerged. In this view windows have been cut into the aluminum body enclosing the vibrator to permit the water to come into direct contact with the coil and also to illustrate the simplicity of construction. The vibrator consists of a coil wound with a high-grade enameled wire surrounded by a laminated steel frame. The device has only one moving part and the vibrator has no moving contacts nor converter to change or direct the current to different ends of the vibrator, as it depends entirely upon the natural alternations of the line. The vibrator is enclosed in a light, dust-proof aluminum case.

Edwin G. Pierce, consulting chemist, Youngstown, O., has completed the equipment of a branch laboratory at Alma, Mich., for chemical and metallurgical work and the general testing of materials. The laboratory is under the immediate direction of Clyde S. Morgan.

Reminiscences of Early Steel Foundry Practice

Evolution of Steel Casting Manufacture and Developments Leading to the Evolution of the One to Three-ton Open Hearth Furnace

By David McLain

OWING to the constantly growing demand for light and medium-weight steel castings, a few remarks on a furnace designed to meet this demand should be of interest to every progressive foundryman. The writer believes it quite appropriate to include a short historical review of what he believes to be the first successful crucible steel foundry in America. Also a few remarks are presented regarding the pioneer steel foundryman, William Hainsworth, who was responsible for many ideas which were successfully developed, including that of designing a small open-hearth furnace.

William Hainsworth, an Englishman, and practical molder, began experimenting in Allegheny, Pa., late in 1870. A year later he had proved to several gentlemen, among whom were Messrs. Irwin and Patterson, that satisfactory crucible steel castings could be produced. The Pittsburgh Steel Castings Co. was formed. A modest plant was erected in November, 1871, at Twenty-sixth street and the Allegheny Valley railroad tracks, Pittsburgh, where the new concern began making crucible steel castings, melting the steel in coke hole furnaces of 30-pot capacity.

In 1877 fire destroyed the plant, but immediately a larger building was erected, in which two 24-pot gas-fired regenerative furnaces were installed. This outfit made its own artificial gas. These furnaces, in addition to the coke holes, more than trebled the output, although the coke holes were operated only intermittently.

Some Early Reminiscences

The writer entered the employ of this company in November, 1877, as general utility boy. His duties combined carrying Mr. Hainsworth's breakfast, with those of coremaker, errand boy, etc. I was soon given a molder's bench, at which were made plow-shares, stamps, shoes, dies and miscellaneous castings. The molders were paid $2.50 per day to make 50 plow-shares and 6 cents each for any over, and it was no trick to make 10 to 15 extra. I was only 14 years old at that time. I had access to Mr. Hainsworth's home and performed many little duties for him; therefore you will pardon this reference, if it leads you to believe I had a stand-in with that gentleman.

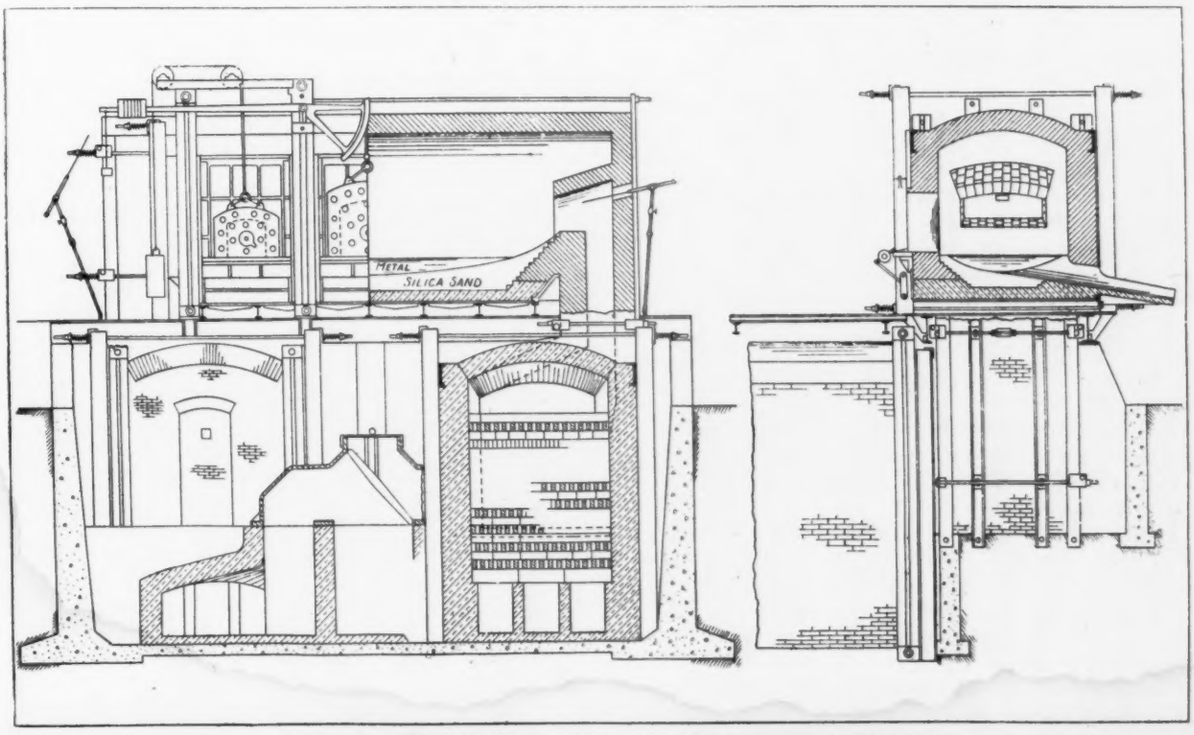
But to return to the subject, the demand for steel castings increased from day to day, and in a few years the company was called upon to make large steel castings that would scarcely be attempted by crucible steel foundrymen today. Frequently it poured castings weighing from 7000 to 8000 pounds, requiring the entire furnace capacity of 70 to 80 crucibles.

On such occasions it was necessary to secure the assistance of outside *pullerouts,* who brought their own tongs and leggings, in order to pull their share of pots, as speed was of the utmost importance. These men were employed at the Hussy-Howe plant, and were glad of the opportunity to earn $2 each for about 10 minutes' active work, drawing their share of 70 to 80 pots which were emptied into a bottom-pour ladle.

To the foundryman today, it may appear amusing to learn that great secrecy and caution were exercised in handling mixtures by those whose duty it was to oversee this part of the business, and symbols instead of names were used to specify alloys for steel mixtures. For instance, *X* might represent oxide of manganese, *XX,* 80 per cent ferromanganese, etc.

Chromium and nickel were used by this firm in their crucible steel mixtures

Presented at the annual meeting of the American Foundrymen's association.



GENERAL ARRANGEMENT OF SMALL OPEN-HEARTH FURNACE

many years before the average foundryman was aware of their wonderful qualities when alloyed with steel.

The writer used nickel and chromium in producing piercing balls, or thimbles, as they were called, also rolls, for the Elwood Weldless Tube Co., Elwood, Pa., when this concern first began the manufacture of its products. These parts had previously been obtained from Sheffield, Eng., at a cost of 40 cents a pound, but our firm made a nice profit of 25 cents a pound.

Next in importance were the facing sand mixtures, which were entrusted to an old German whose first name was "Andy", and woe unto the man or boy (except the writer) who tried to invade the shed in which the sand mixtures were made. Ground coke, crucibles and fire brick, mixed with loam and German clay were all used before it became known that silica sand was the best refractory. Molasses, glue and German clay diluted with water were used as binders and to wet-down the various mixtures.

In 1880 the Hainsworth Steel Co. was formed and a plant was built directly across the Allegheny Valley railroad tracks. A bessemer converter was installed to make billet steel, but as the billet market fell off a few years later, the company commenced the manufacture of bessemer steel castings.

In 1884, another bessemer vessel, 7 tons capacity, was installed in the old plant of the Pittsburgh Steel Castings Co. This was the first bessemer converter in the United States devoted exclusively to the manufacture of bessemer steel castings.

Gun Made of Bessemer Steel

In 1887 Mr.. Hainesworth cast a gun of bessemer steel, and as he expected to revolutionize gun-making, it was a great disappointment to him, his associates and Pittsburghers in general, when it failed to undergo the test. He maintained that the test was not fairly conducted, and could not be coaxed into trying again. He also expected to cast projectiles, but the government tests were so severe it was not a profitable operation. One pin-hole would cause rejection. In 1890 the Hainesworth Steel Co. was sold to the Oliver Steel Co.

Great difficulties were encountered for many years while operating a 7-ton converter in the old plant, as a large number of molds were poured with only a jib crane to handle them and all the ladles of steel. All the castings had to be annealed, but it was noted later that the best converter metal when annealed was not the equal of unannealed open-hearth steel.

Mr. Hainesworth at one time anticipated a discontinuance of the crucible furnace, after he installed the bessemer, but he was disappointed, as the metal had neither the temperature nor the fluidity to run light castings. This was discouraging and at his home he frequently expressed the opinion that some man would design a small open-hearth furnace to melt one or two tons of steel for small castings.

Early Furnaces Short-Lived

Before and since then, many furnaces, ranging in capacity from one to five tons, have been built. They produced steel satisfactorily in much shorter time than was possible in larger furnaces, but in most instances the life of the furnace was limited owing to the burning-out of the lining and roof. Relining these furnaces after a few heats increased the cost of production to an exorbitant figure and the idleness due to these frequent shutdowns made the small furnace impractical, without a spare unit in reserve. This rapid burning-out of the lining was attributed to the radiated heat from the walls and roof, which was greatly contracted in size, causing an enormous increase in the temperature of the furnace.

Mr. Hainesworth searched Europe for small furnaces to replace the crucible. He even brought several expert furnace builders to our plant who built furnaces, and while constructing them boasted about the quality of the product they would produce. But they all fizzled out, and we never succeeded in getting a heat of hot, fluid metal. Mr. Hainesworth was firm in his belief that a successful furnace of this type could be built, and the best proof of this was that he brought these experts from Europe and spent thousands of dollars in an endeavor to do away with crucibles.

In 1896, a 20-ton acid open-hearth furnace was installed in a new plant that was built, piece by piece, always maintaining a portion of the old roof for the men to work under. The molders worked night or day, so as not to lose any time while dismantling the old building and the bessemer department, which was abandoned entirely.

No Demand for Annealed Castings

When the open-hearth furnace was about completed, a capable melter from Chester, Pa., was engaged, who made good steel from the start. Although we had been making steel castings for 25 years, it was quite evident that the open-hearth steel was superior to the product of the crucible or converter, providing the same care was exercised in preparing the molds. We had eight annealing furnaces for crucible and converter castings, so we were prepared to handle all kinds of castings, either large or small, but we seldom were requested to anneal the open-hearth steel.

There was a considerable reduction in defective castings made from open-hearth steel as compared with converter metal in pouring the same patterns. This was especially noticeable in the castings which were most liable to crack when poured of converter metal.

We soon made new records which I believe have never been surpassed and seldom equalled since. Our losses were frequently less than 2 per cent on a year's run and were approximately 1 per cent for certain periods. Some months the charges for returned castings amounted only to from $20 to $80.

Mr. Carter, our first melter, frequently discussed with the writer the possibilities of designing a small open-hearth furnace, but before deciding on anything definite he left the Pittsburgh district and it was not until he located in Milwaukee, a few years ago, that we decided on a design.

The First McLain-Carter Furnace

Drawings were made, and in December, 1915, we accepted a contract to build a 2 to 3-ton unit for the Standard Crucible Steel Castings Co., Milwaukee, March 2, 1916, we melted the first heat, about 3000 pounds of metal. This firm was using 30 crucibles per day, at a cost of $5 each. They were scrapped after three to five heats. The saving on crucibles alone paid for our furnace in 80 days. Our furnace will melt from three to five heats per day and barring some minor repairs, we believe, it will stand up for years, producing fluid steel of the highest temperature.

The Standard Crucible Castings Co. had operated four crucible furnaces of the Milwaukee type for seven years, confining its product to castings weighing less than 100 pounds. Consequently, the shop had no cranes, of either the jib or traveling types. An order was placed for a crane when it placed the order for our furnace, but the latter was operating several months before the crane was installed. Great credit must be given the foundry executives for manipulating their scant equipment to take care of 6 to 10 tons of liquid steel per day.

To convey an idea of the crude manner in which the first heat was handled, permit me to digress for a moment. Overhead was an 8-inch wood beam to which was fastened a 6-foot length of a 1 x 3-inch flat bar. A block and tackle was suspended from this bar directly in front of tapping spout. When the metal was tapped, it was found that the chains would not work, either to raise or lower the ladle and we were compelled to *move the molds up to the ladle.*

Melters and steel foundrymen in general claimed that this furnace would burn down in 30 days, but, strange to say, it melted 694 heats without relining.

It also was contended that excessive oxidation would result on account of the shallow bath. The usual loss in open-hearth melting is from 8 to 10 per cent, and with good melting practice we do not believe that it will exceed 10 per cent in this small unit.

Experience with our furnaces has proved, we believe, that in normal times it will melt steel at a cost of $22 to $24 per ton in the ladle, which is about half the cost of crucible steel in the ladle, when crucibles are selling for $2.25, with oil at 3 to 4 cents a gallon and boiler punchings from $14 to $16 a ton. We use standard bessemer pig iron and 85 per cent low phosphorus scrap, unless a very low phosphorus steel is specified, when, of course, it is advisable to use some low phosphorus pig iron.

The general arrangement of the furnace is shown in the accompanying illustration. This drawing shows a cross-section of the hearth, checker chamber and flue, and also an external view of the charging side of the hearth. One burner is in position for melting, while the other is withdrawn. The air chamber on the side, in which the burner is located, is supplying hot air to the furnace, while the waste gases are storing up heat as they pass through the regenerator on the other side. The drawing shows the platform approximately 4 feet above grade. This is advisable when it is intended to wheel material onto the platform; otherwise the furnace and platform may be raised 8 feet above the floor, thereby dispensing with a concrete pit. Then, of course, an elevator is necessary.

Oil Used for Fuel

Oil is used for fuel and when melting five heats per day, 70 gallons are required per ton of steel, although 65 gallons or less are sufficient when melting continuously. Afternoon heats of two tons each can be melted and poured in from 1 hour and 40 minutes to 1 hour and 50 minutes, while the first morning heat may require 2 hours and 15 minutes to 2 hours and 30 mnutes. Afternoon heats of 7000 pounds have been melted in 2 hours and 15 minutes, but the average time for a 7000-pound heat is 2 hours and 45 minutes. Several 8500-pound heats have been charged, melted and tapped in 3 hours or less in the afternoon.

While the claim has been made that a fire must be kept in this furnace continuously, whether it is working or not, permit me to state this is a mistake. It is true, we keep the furnace warm by using 40 or 50 gallons of oil every five or six hours to maintain a high enough temperature so that the silica brick will be prevented from spalling, and to avoid the undue contraction of the furnace. If for some reason steel were not made for a week or more, it would require approximately 200 gallons of oil each 24 hours to maintain the desired temperature. This furnace is provided with ample regenerators, apparently out of all proportion to its size.

At least one heat per day of 4000 to 4500 pounds is poured over the lip and shanked for bench molds, as in gray iron practice. Every steel foundryman who has been privileged to watch one of these heats poured has observed the fluidity of the metal. It will pour from 150 to 200 or more molds, some of which may contain 20 castings weighing only a few ounces each. The quality of the metal will depend on the material and care used by the melter. The foundry practice also must be good as in all other cases.

While one ton of steel may be melted per heat, at about half the cost of crucible steel, still we do not recommend a furnace built for 1-ton heats. The investment in a 1-ton furnace is too heavy. The investment, however, becomes doubly safe with a flexible unit that will melt from one to five tons.

War Revenue Act and Its Relation to Taxpayers

Enormous Taxes Are Necessary to Raise the War Budget —American Capital Must Now Undergo the Supreme Test

By Daniel C Roper

WHEN the full significance of winning this war is properly understood, it will be apparent that no country ever chiseled into statute a measure of greater importance than the war revenue act of Oct. 3, 1917. This law undertakes to provide a large portion of the necessary money to defend and perpetuate those institutions to which our forefathers devoted their lives. In this sense it is a beacon light toward which people the world over confidently look, for the liberties of our allies are equally dependent with ours upon the necessary financial support which this act undertakes to provide.

It is an interesting law in that it more generally distributes the burden of taxation than any internal revenue measure in the history of our country. It touches more nearly every phase of industry and, therefore, becomes of greater personal interest to our people than any previous tax measure. Because of decreased exemptions, the personal income tax will reach six or seven million persons who have heretofore not made returns. This number includes a large proportion of farmers, a vast number of retail merchants, salaried employes, wage earners and laborers. In addition, there is an estate tax, a capital stock tax on corporations, an excess profits tax on individuals, partnerships, and corporations, and excise taxes on dealers in a large number of commodities, a variety of stamp taxes, a tax on admissions and dues, a tax on public facilities, such as railway transportation, telegraph and telephone messages, insurance policies, occupational taxes and the special taxes on alcoholic and non-alcoholic beverages, cigars, tobacco, perfumeries, and various other objects. Finally, there is the munition manufacturers' tax and the increase in postage rates. In short, this war revenue act is the most comprehensive tax law ever enacted, and the man who escapes its provisions is indeed an inconsequential member of his community.

Some persons have undertaken to criticise the law and to point out its crudeness and inequalities. Imperfections in the law are not to be wondered at when it is remembered that so many of its provisions invade virgin territory. A careful study of the act, however, will convince the unbiased student that it is a remarkable piece of legislation, requiring only an intelligent and sympathetic attitude alike on the part of administrative officials, congress and the people to bring it into workable form and to accomplish its purpose without destroying business or visiting undue hardships upon taxpayers who properly co-operate in its administration. But to accomplish these desirable ends the sympathetic and patriotic cooperation of congress, the administrative officials, and taxpayers are each and all indispensable. If they are assured,

Address delivered Dec. 13, at Washington, D. C., by Daniel C. Roper, Internal Revenue Collector, before editors of the trade press of the country.

there need be no undue anxiety. A good law may be ruined by reckless methods of administration; and a defective law vastly improved by intelligent and painstaking administration.

Considerations of this kind prompted the secretary of the treasury, soon after the passage of the law, to call to my assistance in interpreting its excess profits provisions, nine able and representative American business men. For several weeks they have devoted their entire time, without compensation, to hearing and studying the views of taxpayers regarding the excess profits law to the end that they may be able to give to the commissioner of internal revenue information as to business based upon fresh and up-to-date knowledge. The end sought is to collect the tax which the law imposes with the least possible hardship and inequality. These excess profits advisers have brought to the assistance of the bureau of internal revenue a dependable knowledge of the viewpoint of the taxpayer and of business conditions which is essential to the practical solution of the problems with which we are at the present time confronted.

Digesting Business Conditions

This I believe to be the first time that any government department has worked out a co-operative plan for ascertaining and digesting the business and industrial conditions affected by a federal law. It is a step toward that understanding that should prevail in every Democracy between the people and those whose duty it is to administer the law.

In furtherance of the desire of the department to solve its problems in the light of actual conditions, rather than of superficial considerations, there has been called to its assistance a group of legal advisers composed of representative lawyers of very broad experience, who are patriotically giving, without cost to the government, assistance that we could not purchase in interpreting the law.

Following the publication soon to be made of the rules and regulations for the administration of the law, is to come the tremendous task of actually collecting the taxes. The period between Jan. 1 and March 1, is fixed by law for the filing of returns by the taxpayers. Payment must be made befor June 15.

A Campaign of Education

The campaign of administration involves a campaign of education. It is intended that every available avenue shall be utilized for informing taxpayers as to the amount of tax for which they are liable and how, when, and where their taxes are to be paid.

To this end, the field force of the bureau is to be expanded and reorganized and specially charged with the duty of coming into personal contact, between Jan. 1 and March 1, as nearly as possible with every person subject to this tax.

Schools of Tax Instruction

Schools of instruction are to be held in every collection district and early in the new year a competent revenue official will be sent into every county in the United States. These agents will be provided with all necessary forms and will be qualified to render assistance to taxpayers in making out their returns. Public announcement will be made through the press of the dates when these men will visit each community and taxpayers will be urged to call on them promptly. Their services are free and there should be no necessity for anyone to incur expense in the preparation of his return.

Plans also have been perfected whereby the revenue field officers are to have the co-operative aid of the state and county councils of national defense, not only in disseminating information regarding the law, but in arousing and stimulating a patriotic attitude toward war taxation. Volunteer assistance will be rendered also by committees of bankers, accountants, postmasters, and by the highly trained field force of the department of agriculture.

We hope so thoroughly to cover the field that ignorance of the law may not be consistently offered by any taxpayer as an excuse for failure to comply with its requirements. It must not be overlooked that the law plainly imposes upon the taxpayer the duty of seeking the revenue officials and of complying with its provisions, and prescribes rigid penalties for failure to comply with them.

Simple Tax Returns

As a practical aid to the millions of new taxpayers, we have devised a comparatively simple, self-explanatory income-tax return form for the use of persons having a net income of less than $3000. Many of these people do not keep books or records of accounts. They are not familiar with accounting terms and methods and would be unnecessarily confused if confronted with a form which carried the intricate questions required by the surtax and excess profits tax features of the law. Consequently, the man of small income, who is subject only to the normal tax of 2 per cent, is to have the benefit of a schedule drafted in the simplest possible form and language.

The man of larger income, who is required to compute surtax and excess profits taxes in addition to the normal tax, will be required to use more detailed forms with appropriate instructions.

As illustrative of some of the recommendations touching the excess profits tax, which are now being considered with a view to presenting them to the secretary of the treasury, the following among others may be cited:

Allowance of reasonable salaries in the case of partnerships and individuals, in order to place them on an equal basis in this respect with corporations. The effect of this allowance would be to transfer a reasonable salary allowance from income derived from capital invested, all of which would otherwise be taxable under the graduated rates of section 201, to section 209 which imposes a flat rate of 8 per cent on salaries and other income. It is readily seen that such a construction is fully within the spirit and intent of the law. It is within the letter of section 209, which allows each individual who really earns a salary by personal exertion, no matter in what business connection, to have it taxed under the 8 per cent provision of section 209.

That the 8 per cent rate be made to apply to professional men even if a small amount of capital is employed by them.

That merchants be permitted to make inventories of merchandise either at cost or at market value. That brokers be included, on the ground that they are merchants of securities.

That any taxpayer who is content with a 7 per cent deduction upon his invested capital will not be called upon to make a complete return of his prewar capital and income.

The secretary of the treasury has approved of a treasury decision allowing the full exemption provided by the congress to corporations in sections 201 to 203. The difficulty here arose that a definite exemption was provided for in section 203, but the mechanics provided for applying the exemption in section 201 were left incomplete in a limited number of cases. Hence this decision carries out the manifest intent and purpose of the congress.

Without further taxing you with the details of our study of the law, I would state that we are confident that the rules and regulations to be adopted will interpret the law in a manner which will be in full accord with its intent, and in harmony with the methods of legitimate business and the rights of the taxpayers. It is neither hoped nor expected that these regulations will please every taxpayer. They would not be good regulations if they did. The spirit of honest co-operation with the taxpayer, however, is being instilled into every employe of the bureau and will be insisted upon at all times and in all places.

All taxation is burdensome. War taxes are necessarily so because they are heavy. The government's needs are pressing, however, and must be met. The law imposes an obligation upon every citizen which he must meet hon-

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

FORMULAS FOR THE BRASS FOUNDRYMAN

Names and Composition of Miscellaneous Alloys.

Typewriter Metal

	Per cent
Copper	57
Nickel	20
Aluminum	3
Zinc	20

Place the nickel in the bottom of the crucible with copper on top; use charcoal and borax as a flux; when molten, add the aluminum and if too hot, cool before adding the zinc. Used for typewriter parts.

Kern's Silicon Hydraulic Bronze

	Per cent
Copper	76.75
Yellow brass clippings	10.00
Tin	12.00
Zinc	1.25
Silicon copper	2 ounces

We do not recommend the use of silicon copper as a deoxidizer in bronze, when the latter contains lead.

Geage's Alloy

	Per cent
Copper	60.00
Zinc	38.50
Iron	1.50

Geage's alloy is one of the iron-brasses that has been supplanted largely by the advent of manganese bronze.

Non-Gran

	Per cent
Copper	87
Tin	11
Zinc	2

The analysis of this metal showed a small amount of lead and iron; the former probably was an impurity of the zinc and the latter, a deoxidizing agent.

FORMULAS FOR THE BRASS FOUNDRYMAN

Names and Composition of Miscellaneous Alloys.

Argentan

	Per cent
Copper	52
Nickel	26
Zinc	22

Argentan is a German silver designed for use as an imitation silver.

Needle Metal

	Per cent
Copper	84.50
Lead	2.00
Tin	8.00
Zinc	5.50
15 per cent Phosphor copper	2 ounces

Place the phosphor copper in the bottom of the pot and charge the copper on top; cover well with charcoal and melt. Needle metal is so called because it is supposed to be sufficiently fluid to run needles.

Japanese Bronze

	Per cent
Copper	83
Lead	10
Tin	5
Zinc	2

Japanese bronze is a free-cutting alloy, and as such is useful for red brass castings that are to be rapidly machined.

Mira Metal (Original Analysis)

	Per cent
Copper	74.755
Zinc	0.615
Lead	16.350
Tin	0.910
Iron	0.430
Nickel and cobalt	0.240
Antimony	6.685

This alloy is claimed to be acid-resistant and for that reason is suitable for making castings that are exposed to the action of acid liquors. Why this should be is not stated. The alloy is too brittle to be of any use and the proper mixture follows:

	Per cent
Copper	74.25
Lead	16.50
Tin	8.00
Nickel	1.00
15 Per cent phosphor copper	0.25

Antimony; zinc, iron and cobalt are omitted.

Place the phosphor copper in the bottom of the pot; charge the copper on top and melt together with the 1 per cent nickel; then add the tin, cool to pouring temperature and charge the lead.

estly, patriotically, and we hope, cheerfully. We have many evidences that American patriotism is responding to this condition.

The man who pays his Liberty tax in full, without question or murmur, is no less a patriot than the man who invests in the Liberty bond or volunteers his services for military duty. This is the spirit of America and I congratulate our country on the patriotic manifestation of co-operation by your great agency for publicity.

Gas Trouble Necessitates Pattern Reconstruction

By M. E. Duggan

If in doubt as to the construction of a pattern, don't wait until it is finished before asking the advice of the molder. The molder may reject the patternmaker's product and demand alterations to suit his own requirements.

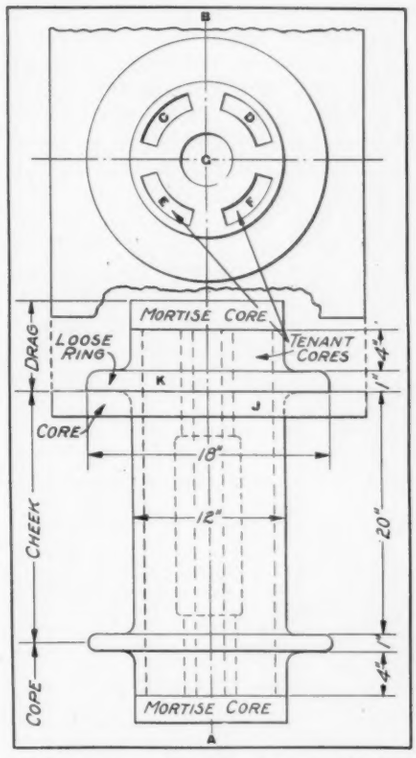
The pattern for a cable winding drum, shown in the accompanying illustration, is an example of a faulty model. It is somewhat different from the ordinary drum pattern, being constructed with four openings represented by *C, D, E* and *F,* in the drawing, which extend entirely through the cylinder, and a chambered hold, *G.* The patternmaker split the pattern through the center at the line *AB,* one-half of the pattern thus being in the drag and one-half in the cope. This necessitated molding in a horizontal position. At both ends of the drum were mortise cores made with openings that matched in shape and position the cores *C, D, E, F* and *G.*

The molder could not make use of this pattern owing to the fact that he could not close the cope over the ends of the mortise cores in such a way as to prevent gas or metal from gaining entrance into the pasted joints of the assembled cores. Then again, there was no way of liberating gas from the cores in the cope. For these reasons the pattern was changed to enable it to be cast on end at the direction of the molder. The mold was finally cast in the following manner:

The two halves of the pattern were fastened together and the ring, *K,* was made loose on the drum. The pattern was placed on a bottom board, cope and down, and sand was filled into the cope and cheek flasks up to *J,* a slab core the diameter of the drum and having a hole in the center. The core, *J,* was lowered into position over the drum and under the ring *K* and the latter was placed in position. After this operation the filling of sand was continued and the mold was completed. Next, the drag flask was lifted and the loose ring, *K,* was drawn out of the mold, after which the drag was finally returned to its place and the mold rolled over for the finishing of the cope.

Improving the Method of Making Mill Brasses

Mill brasses which we have been making, that weigh approximately 200 *pounds and are* 18 *x* 14 *x* 2 *inches in dimensions, are badly honeycombed, many of the holes being the size of peas. Apparently, we exercise every precaution in melting, using both salt and charcoal on the copper. The alloy consists of copper,* 92 *per cent; tin,* 7.4 *per cent; zinc,* 0.06 *per cent. We also have tried copper,* 92 *per cent; tin,* 7.4 *per cent and phosphor tin,* 0.06 *per cent. Varying the pouring temperature of the different casts has not affected and improved the metal. Kindly let us know whether drying the mold will eliminate this trouble.*



HOW THE PATTERN WAS CHANGED TO PREVENT GAS AND METAL FROM ENTERING PASTED JOINTS OF THE CORES

To overcome this difficulty, we suggest that the alloy be changed to the following: Copper, 87 per cent; tin, 8 per cent; lead, 4 per cent, and 15 per cent phosphor copper, 0.5 per cent. For making the molds, use an open sand such as iron molders use for floor work, but if this is not obtainable, add sharp sand, preferably silica, to the molding sand and also vent the molds. Drying the molds will produce smoother castings provided the walls of the molds are first painted with a good grade of plumbago mixed with water and molasses water; use no substitute for the latter. If the bronze is poured from crucibles into a ladle, be absolutely sure that the lining is thoroughly dry as a green ladle lining produces honeycombed castings.

Use considerable borax in melting, to form a liquid slag which will protect the metal from oxidation. Ordinarily, borax is too expensive to use as a brass foundry flux and it should be mixed with charcoal and a small amount of salt, and if too fluid, sand may be added. The object to be obtained is to form a covering of slag that will protect the surface of the metal from the gases of combustion.

Place the borax, charcoal and salt in the bottom of the crucible, charge the copper, but do not permit any portion of the metal to extend above the top of the pot. Since it is advisable to charge all the copper at one time, use a crucible ring on top of the crucible containing the charge. After the copper has been added, place a few blocks of hardwood on top of the charge and when the copper is barely melted, stir well from the bottom to bring up the flux that may be adhering to the bottom of the crucible. When the copper has a blue appearance underneath the flux, add the phosphor copper, stir thoroughly, add the tin, followed by the lead. Pull the pot five minutes after the white metals have been added and pour.

Sponginess in Pump Liners

We have been experiencing considerable trouble in making pump liners which develop spongy spots after they are machined. We mold the castings upright, using two gates and two risers and we pour with two No. 8 *pots, one on either side of the mold. The alloy we are using consists of copper,* 88 *per cent; tin,* 10 *per cent and zinc,* 2 *per cent.*

A mixture containing copper, 80 per cent; tin, 10 per cent and lead, 10 per cent, is more frequently used for mine pump liners than the 88-10-2 mixture which you are using. However, there is no reason why the latter alloy cannot be employed to advantage. The cause of the porosity is due to unskillful melting which permits the absorption of gases, or of substances that react with each other to form gases as the casting solidifies. This may be avoided by melting the copper under a covering of charcoal and finely crushed bottle glass, and by adding to the copper just before the tin and zinc additions, a small amount of phosphor copper. Ten per cent of the latter will prove sufficient. Some foundrymen prefer to pour these liners from the top, while others pour them from the center, and in the latter case only one-half of the metal drops and the other half rises.

What Proper Routing Did for an Old Foundry

System is the Appeal of the Efficiency Man—It is as Vital in the Foundry as in a Clearing House

By H E Goetz

THE old system was bad and everybody knew it. The routing was haphazard, since the work zigzagged the length of the foundry twice. Due to the poor routing, the crane service was delayed and the cranemen were indifferent, which resulted in the loss of many hours each day. Then, too, the piece price was high and the workmen were afraid to overtax themselves, fearing that the price might be cut. In general, everything went wrong, and fireworks were on the program daily.

The management needed a new man and one was sought in the ranks, who would be capable of reorganizing the plant and of establishing a more efficient system. He soon was found, and with the dismissal of the old superintendent, the change came quickly. "Two things are necessary to show results," the new man said; "one is equipment and the other is common sense."

The reformation started in the routing system, for therein lay the chief hindrance to progress. The fault of the existing routing system lay in the design of the foundry building, which, although quite long, was outgrown six years before the present change in management. In order to increase the floor area, the length of the building was doubled. Notwithstanding this extension, the cupolas were not moved, and when pouring was started, interferences occurred in the crane service between the cupola gang and the jolt-ramming crew. The bumper pit was directly opposite the cupolas in the middle of the building, and its location moved the path of work east from the center, then back again to the west end of the plant, in such a manner that transportation conflicts in the center caused numerous delays in the work. The new plan was to start the work at the east end and to allow it to pass by successive steps to the west section.

After due consideration of the changes planned, labor conditions seemed to make the maintenance of the old piece-work system a desirable, if not a necessary feature for success. Most of the employes consisted of handymen and unskilled labor. The work of the foundry consisted chiefly of large molds, such as frames for compressors and corliss engines, steam and air cylinders, pump bodies and other engine parts. The patterns were delivered to the foundry from the pattern storage and the molds were rammed in iron flasks by a gang of negro laborers. The rammed molds then were conveyed to the finishing floor, the patterns drawn and finished. They were then placed on heavy iron trucks and rolled into the drying oven to bake overnight. In the morning the hot molds were removed from the ovens and conveyed to the layout floors where the cores were placed and the flasks closed. The molds were poured in the afternoon and in the evening the castings were shaken-out and removed to the cleaning, sand-blasting and chipping departments.

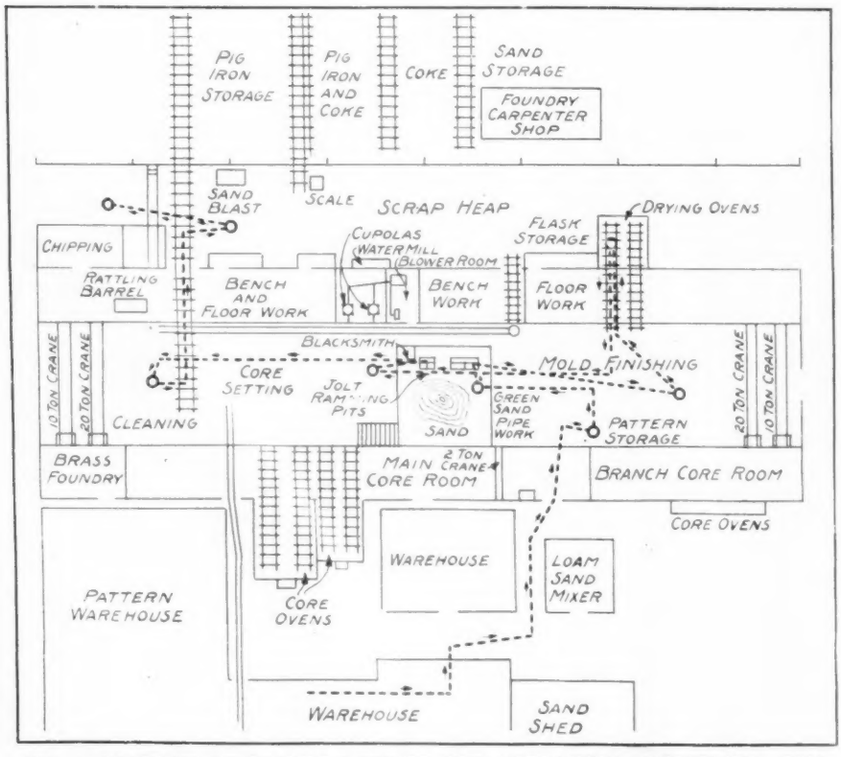


FIG. 1—DIAGRAM OF FOUNDRY UNDER OLD OPERATING CONDITIONS. THE DOTTED LINES SHOW HOW THE WORK PROGRESSED THROUGH THE PLANT IN A HAP-HAZARD MANNER

Reference to Fig. 1 will illustrate the hindrances in the operations under the old system. The dotted lines show the route of the work. A gang of from eight to ten negroes was required to load a large pattern on a truck in the pattern storage, and this was pushed into the foundry, frequently having to be carried over a rough mud passageway, thereby wasting a considerable amount of time on a comparatively simple operation.

The ramming of the molds required from five to six crane operations for cope and drag, respectively. During the first three hours in the morning, while the trucks were being unloaded, unless the cranemen were favorably inclined, satisfactory crane service was almost impossible of attainment. Even when a crane picked up a job, it might have to run the full length of the foundry to make way for one of the other three cranes. Frequently a workman had to wait almost an hour to get a turn at a crane. The removal of the work to the finishing floors was attended with similar delays.

What were the remedies for such a system? Fig. 2 shows clearly how the problem was solved. The first step involved the installation of a narrow gage track for trucks. Rails

were laid, as shown by the diagram and turntables installed at the junctions. By this system it is possible for one man easily to move the heaviest pattern in the shop.

The second step involved placing the jolt-ramming machines at the east end of the foundry. The old bumper pit was filled with waste sand and the smaller machine was removed. The two new bumpers in their new positions made possible the following routing changes: The patterns are now brought in at the extreme east end of the building and the molds are rammed at this point. The molds then are moved only a short distance to the finishing floor and are loaded onto trucks and conveyed to the large drying oven. One crane easily handles the work up to this point, leaving the other three cranes free for the use of the core setting gang and the green sand molders.

Further interruptions in crane service and also dust troubles were reduced by moving the cleaning gang to the yard. A new 10-ton yard crane was added to take up this burden. A 2-ton traveling crane was added to the core room and two air hoists and one monorail air hoist served the new sand bins.

Sand Preparation and Storage

Sand storage and preparation was one of the essential features of the molding practice which received considerable attention. Both fine and coarse sand were widely distributed around the yard. The helpers were required to wheel the sand from the distant storage piles to the molders' floors. To eliminate this extra hauling, a clamshell bucket was purchased for $650 and the sand was loaded from the cars and discharged into bins built alongside the building. Half a dozen narrow gage dump cars were purchased to convey the sand from the bins.

One of the most valuable pieces of machinery installed was a sand mixer which prepares both facing and core sands. The sand-mixing machine receives its charge from one of two hopper openings on the floor level. The new sand passes through a mill provided with rapidly revolving paddles which pulverize and drop it into the first mixing hopper with the other sand. This hopper contains a revolving screw which gradually works the charge to the elevating buckets. These elevating buckets discharge their contents into a rotating riddle about 10 feet above the floor level. The tailings are discharged at the lower end of the riddle while the fine material passes through the screen into the final mixing hopper. In this hopper water is gradually mixed with the sand by revolving paddles and the batch is discharged into a car. The use of the resulting sand greatly increases the uniformity of both cores and castings, as well as reduces labor costs.

The improvement in working conditions was the greatest step toward

(*Continued on page* 44)

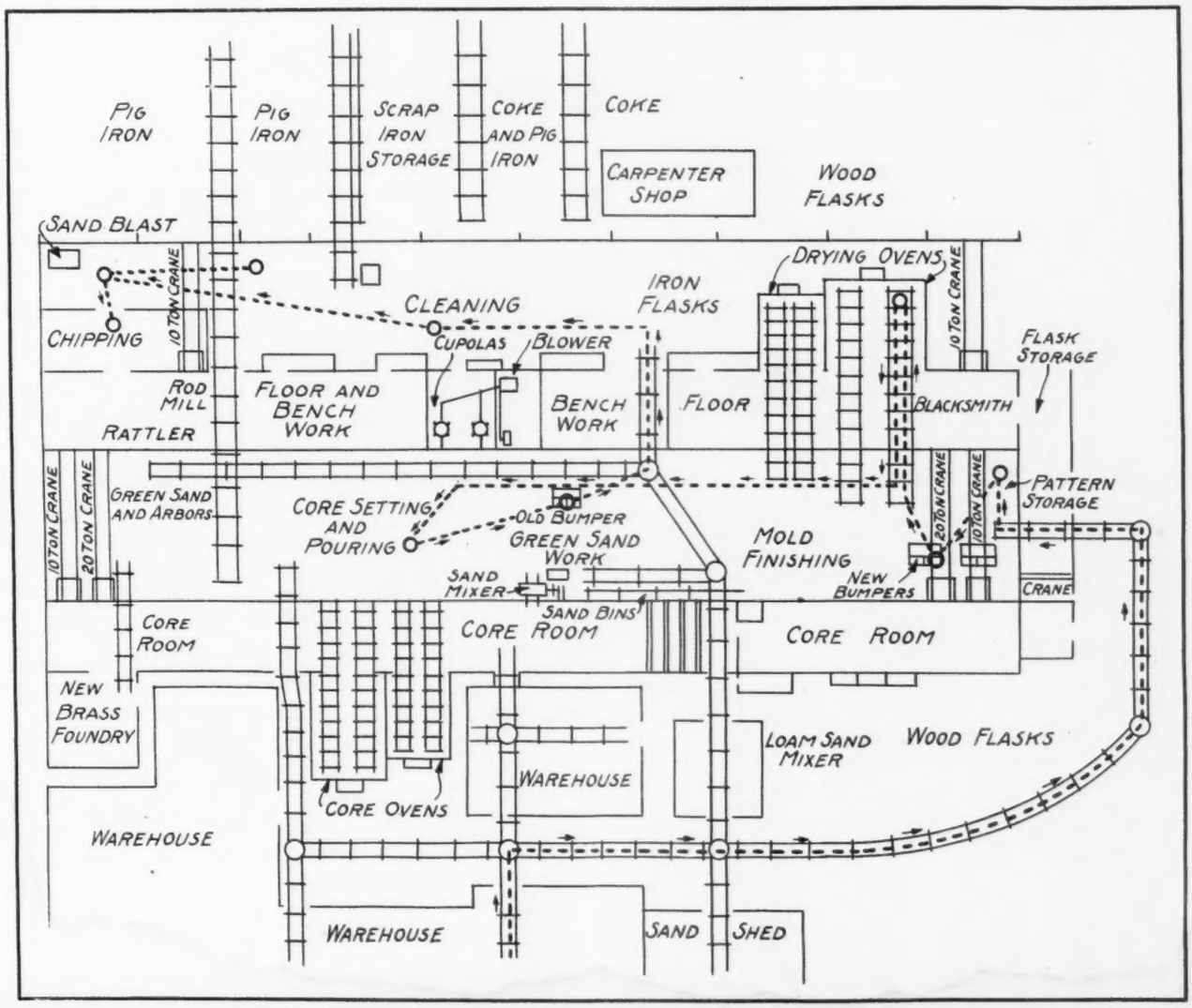


FIG. 2—LAYOUT OF FOUNDRY, SHOWN IN FIG. 1, AFTER NEW EQUIPMENT WAS ADDED AND CHANGES WERE MADE. THE DOTTED LINES SHOW THE PROGRESS OF THE WORK

THE FOUNDRY

A monthly journal devoted to all branches of the foundry trade

Published by

The Penton Publishing Co.

Penton Building, CLEVELAND

BRANCH OFFICES

BIRMINGHAM, ENG.....Prince's Chambers
CHICAGO.....1521 Lytton Bldg.
CINCINNATI.....128 Opera Place
NEW YORK.....508 West Street Bldg.
PHILADELPHIA.....1316 Land Title Bldg.
PITTSBURGH.....2148-49 Oliver Bldg.
WASHINGTON, D. C.....708 Metropolitan Bank Bldg.

SUBSCRIPTION

United States and Mexico.....$1.00 a year
Canada.....$1.50 a year
Great Britain and other Foreign Countries Eight Shillings
Single Copies.....15 cents

Copies published three months or more previous to date of current issue, 25 cents each.

ADVERTISING

All communications relating to advertising copy, discontinuances, etc., must be received on the 10th of the month preceding date of publication.

ENTERED AT THE POST OFFICE AT CLEVELAND AS SECOND CLASS MATTER

Copyright 1917, by the Penton Publishing Co.

Contents

	PAGE
How Cores Are Used to Cut Molding Costs	1
Abell-Howe Co. Establishes Branch Offices	4
Changes in Sales Force of Sullivan Machinery Co.	4
Determination of Moisture in Coke	4
Iron Oxide—Its Effect on Molding Sand	5
Casting Large Guns in the Early Eighties	6
An 80-Year Old Foundry Changes Hands	8
Booth-Hall Electric Furnace Installations	8
Harnessing the Electric Furnace to the Foundry	9
Molding Slag Pots in Dry Sand	11
The Overweight Casting—Its Cause and Remedy	12
Evolution of Cooking and Heating Stoves	17
Preventing the Cupola Bottom from Cutting Through	22
The Preparation and Use of Rapid Nickel Baths	23
Census of the Brass, Bronze and Copper Industry	25
Coating for Ingot Molds	26
Metal Oxidized in Melting	26
New Process of Electric Steel Melting	26
Problems of the Brass Founder	26
Recovering Metal from Solder Sweepings	26
Wanted—A Competent Superintendent	29
Active in Industry at Age of 72	30
Ascertaining the Compressed Air Consumption	31
Zinc Refined by Distillation	31
Correct Way of Making a Gas Engine Piston Pattern	32
Core Box Construction	34
Operating an Electric Vibrator Submerged in Water	34
Reminiscences of Early Steel Foundry Practice	35
War Revenue Act and Its Relation to Taxpayers	37
Gas Trouble Necessitates Pattern Reconstruction	39
Improving the Method of Making Mill Brasses	39
Sponginess in Pump Liners	39
What Proper Routing Did for An Old Foundry	40
Conserve the Coke Supply	42
Personal	43
Iron Mixture for Motor Frames	43
A Simple Hand Sand Rammer	44
New Method of Making Shell Bands	44
Trade Notes	45
Vanadium Bronze Contains No Manganese	45
What the Foundries Are Doing	45
New Trade Publications	46

Conserve the Coke Supply

INADEQUATE transportation facilities are making it increasingly difficult for foundrymen to obtain sufficient supplies of fuel to operate their plants at capacity. The shortage will become more acute during the next 60 days and every expedient should be resorted to for the purpose of relieving the burden on the railroads. Throughout the year the scarcity of cars has made it impossible for the coke operators to maintain production to meet requirements and the output has been curtailed several million tons thereby. Foundrymen generally are too lavish in their use of coke, a habit undoubtedly formed through the necessity of obtaining hot iron and also induced partly by the comparatively low cost of this fuel prior to the war. It no longer is an economic, but a patriotic duty for foundrymen to conserve the supply of coke, and by doing so they will release thousands of cars for the transportation of materials equally as essential to the manufacture of munitions as coke. In hundreds of small gray iron foundries the melting capacity is far in excess of that of the molding floor and where heats are taken off daily, just as satisfactory results could be obtained by melting two or three times a week. In other shops taking off heats every other day, two heats a week might suffice. An immediate saving would be effected in the fuel beds of the eliminated heats and furthermore, these foundries would operate more efficiently since it is well-known that on pouring days in these small shops the number of molds produced does not measure up, hour-for-hour, with the output on exclusively molding days. While hot iron is essential to good foundry practice, the tendency is toward too high a fuel ratio. Foundrymen have a weakness for jamming their cupolas full of coke, apparently not realizing that by so doing they are retarding, rather than expediting melting. Furthermore, with high ash and sulphur to contend with, and this is more pronounced today than ever before, the melter should be instructed to use only a sufficient amount of coke to insure hot iron. Even in the best conducted plants, there is a reckless waste of coke. As a rule, foundrymen are content with their cupola practice if the iron is hot and clean, little realizing that the coke consumption might be reduced considerably by a few carefully conducted experiments. Also, it is advisable to seek outside advice from experts in cupola practice, who often are able to effect economies that will pay for their services in a few weeks. The salamander also is a prodigious consumer of coke and should be consigned to the dump. In addition, it fills the foundry with poisonous gases and several states have legislated against its continued use, urged on undoubtedly to some extent by the pleas of safety-first advocates. Enormous tonnages of coke could be saved annually for better and more expedient purposes if a method of heating the foundry, other than that effected through this unit were adopted.

Personal

John A. Green has been appointed superintendent of the foundry operated by the Pittsburgh Crucible Steel Co., Midland, Pa.

S. Griffith, formerly foundry superintendent of Fairbanks, Morse & Co., Beloit, Wis., now is affiliated with the South Side Foundry & Machine Co., Charleston, W. Va.

Lewis A. Way, formerly superintendent of the Duquesne Steel Foundry Co., Pittsburgh, is now assistant to the president of the Lewis Foundry & Machine Co., Pittsburgh.

Sherwood H. Standish, formerly assistant superintendent of the Northwestern Malleable Iron Co., Milwaukee, has been appointed works manager of the Stowell Co., South Milwaukee, Wis.

A. H. Jameson, now affiliated with the Malleable Iron Fittings Co., Branford, Conn., has been elected vice president and general manager of the Bayonne Steel Castings Co., Bayonne, N. J.

Felix B. Atwood, who has been affiliated with the Osborn Mfg. Co., Cleveland, during the past six years, is now connected with the Springfield Facing Co., Springfield, Mass., manufacturer of foundry facings and supplies.

Frank W. Richardson has been placed in charge of the office established at 39 Cortlandt street, New York, by the Nagle Corliss Engine Works, Erie, Pa. This company builds air compressors, vacuum pumps and corliss engines.

George A. Rees has been appointed general purchasing agent of the Chicago Pneumatic Tool Co., Chicago, to succeed R. S. Baker who is compelled to devote his entire time to his official duties as auditor of this company.

W. C. Greer, formerly superintendent of the foundry operated by the Railway Supply & Equipment Co., Seward, Pa., has been appointed general foreman of the casting plant of the Leetsdale Foundry & Mfg. Co., Leetsdale, Pa.

J. H. Schneider, formerly assistant superintendent of the plant of the Gurney Electric Elevator Co., Honesdale, Pa., in charge of special organization and engineering work, has been appointed chief of the efficiency department of the American Tool Works Co, Cincinnati.

F. J. McGrail, who for several years has been superintendent of the foundry operated by the Struthers-Wells Co., Warren, Pa., has resigned to become affiliated with the pattern lumber sales force of Smith, Fassett & Co., wholesale lumber merchants, North Tonawanda, N. Y.

G. A. Schneider, formerly affiliated with the San Francisco sales organization of the Western Electric Co., New York, has been appointed manager of the Buffalo branch, succeeding J. W. Tabb, who has been transferred to the main office in New York.

James Lannigan has been appointed superintendent of the plant of the Portage Foundry Co., Akron, O. He formerly was in charge of a foundry operated by the American Malleables Co., Lancaster, N. Y., and later was affiliated with the Frontier Iron Works, Buffalo.

A. E. Short has been appointed factory manager and A. T. Grindle foundry superintendent of the plant operated by the Stewart-Warner Speedometer Co., Beloit, Wis. Malleable, gray iron, brass and aluminum castings are made in this company's foundry.

MICHAEL F. KERBY

N. B. Payne has established an office in the Havermeyer building, 25 Church street, New York, and will supply traveling cranes with newly developed features to the trade. Mr. Payne formerly was associated with Manning, Maxwell & Moore, Inc., New York, and has had a wide experience in this line of work.

B. G. Barr, superintendent of the foundry operated by Fairbanks, Morse & Co., Beloit, Wis., is convalescent at the Mayo Bros'. sanitarium, Rochester, Minn., following an operation. Prior to his present connection Mr. Barr was superintendent of the foundry operated by the General Electric Co., Erie, Pa., and the Baldwin Locomotive Works, Philadelphia.

Charles T. Bragg will accept the position of works manager of the Detroit plant of the Michigan Smelting & Refining Co., Jan. 1. Mr. Bragg was chemical engineer of the Ohio Brass Co., Mansfield, O., for a period of six years and for four years was technical director for Berry Bros., Detroit. Mr. Bragg is a past president of the Detroit section of the American Chemical society.

A. W. Wagner, formerly president of the Terre Haute Malleable & Mfg. Co., Terre Haute, Ind., and of the Decatur Malleable Co., Decatur, Ill., has organized a new company known as the Wagner Castings Co., which has taken over the Decatur Foundry Co.'s plant. Gray iron castings now are being manufactured, but the production of malleable castings also is contemplated. Mr. Wagner has been elected president of this company.

Death of Michael F. Kerby

Michael F. Kerby, president of T. P. Kelly & Co., New York manufacturer of foundry facings, equipment and supplies, died in that city Wednesday, Dec. 5. Mr. Kerby enjoyed a wide acquaintanceship among foundrymen of the United States, his affiliations with the supply industry having extended over a period of 32 years. He entered the employ of T. P. Kelly & Co. in 1885 and in 1888 he was placed in charge of the Chicago office of this company where he remained until 1890. In the early nineties he sold supplies in Pennsylvania, Ohio and New York. Subsequently he was transferred to the home office and during the frequent absences of the late T. P. Kelly on trips abroad, Mr. Kerby managed the business. In 1911 he was elected president. Mr. Kerby also was president and director of two other corporations and was a member of the New York Athletic club, the Elks and the American Foundrymen's association.

Iron Mixture for Motor Frames

By W. J. Keep

Question:—We are experiencing considerable difficulty in obtaining the proper mixture for motor frames. The users of these castings claim that their magnetic qualities are not satisfactory. We are using two grades of iron, 60 per cent of the one grade analyzing silicon, 3.00 per cent; sulphur, 0.20 per cent; phosphorus, 0.70, and manganese, 0.60 per cent; 20 per cent of another grade analyzes silicon, 2.25 per cent; sulphur, 0.18 per cent; phosphorus, 0.46 per cent, and manganese, 0.99 per cent. The re-

mainder of the charge consists of re-melt. We charge 900 pounds of coke on the bed and 180 pounds for each succeeding charge with 2000 pounds of iron.

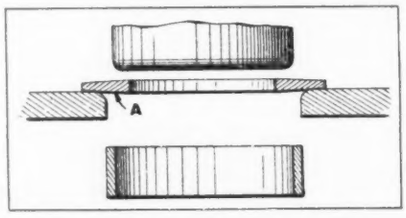
Answer:—The analyses which you have given evidently are incorrect and we suggest that drilling be made for proper analysis. The furnaces from which you have purchased this iron would not produce a metal containing as much sulphur as your analyses show. The correct percentage of sulphur should be 0.02 and 0.018 in both cases. Therefore, your castings would contain approximately 2.80 per cent silicon; 0.06 per cent sulphur; 0.64 per cent phosphorus, and 0.70 per cent manganese.

It is suggested by Porter that dynamo frame castings conform to the following analysis: Silicon, 2 to 2.50 per cent; sulphur, 0.08 per cent; phosphorus, 0.50 to 0.80 per cent, and manganese, 0.30 to 0.40 per cent. For smaller frames he recommends silicon, 2.00 to 2.50 per cent. The castings made from the two grades of iron which you are using are low in silicon and high in manganese. The sulphur content as advised is correct if the pig iron is normal. The phosphorus content also is satisfactory. The combined carbon should be 0.20 to 0.30 per cent, and total carbon, about 3.00 per cent. However, correct analyses of the iron which you are using may give you a clue to your troubles. It is difficult to make a good mixture with two grades of iron only for the reason that if either iron changes, it greatly influences the mixture. The use of another iron with higher silicon and more manganese is recommended. It would be safer to use the iron of the same analysis from four furnaces, than to use only two separate grades.

The Brown Specialty Machinery Co., Chicago, has leased a plant, 75 x 150 feet, to be located on Maplewood avenue, near Forty-eighth street. Elmer A. Rich is president of this company, which specializes in coremaking machines and sand-blast equipment.

New Method of Making Shell Bands

A practical method of making copper rifling bands for shells has been devised and patented by George E. Neuberth, Newark, N. J. The shell band is made by converting a flat copper ring into a band by the use of a punch and die. If the ring is punched out of sheet copper, it will necessarily be flat. The first operation, therefore, is annealing to make it soft, after which it is rolled to give it a taper from the inner to the outer diameter, as shown at *A*, in the accompanying illustration. This operation extends the ring, and at the same time reduces its thickness. The next step is to upset the ring by forcing it through a die, as shown. This turns the ring inside out and the part that formed the inside circumference of the ring is now the bottom of the band. The object of tapering the ring is to provide excess metal at the inner diameter to compensate for the flow from this section to the other portions of the band, thus making it of equal thickness throughout.



SHELL BANDS MADE BY NEW METHOD

Small bands require no further treatment, but in making large bands it is necessary to insure straight walls for rolling the edges to size and to force them through a finishing die, to true and square the bands and to bring them to the exact size required. After being subjected to this treatment the bands are finished. It is apparent that this process is a considerable improvement over the method of making bands by first casting a deep ring in a sand mold and then subjecting it to a rolling process to make the metal more dense and to bring it to size; this is followed by the annealing and pickling operations.

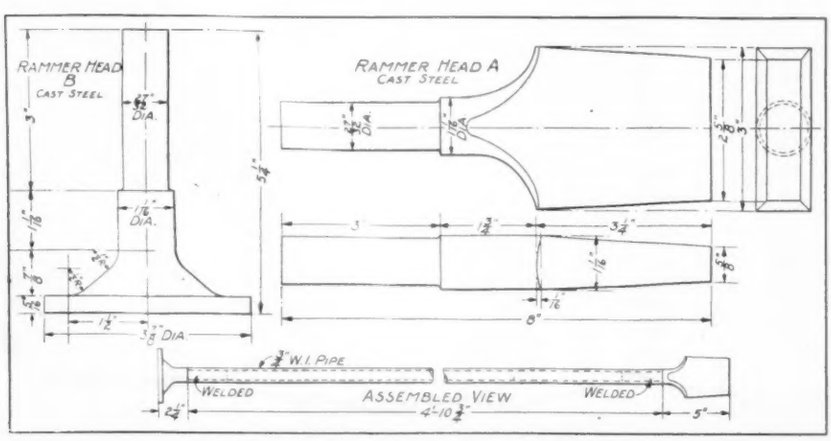
It is difficult to cast a copper band or deep ring, such as required for these shells. A flat ring, however, is a simple casting proposition, and if a deoxidizer is used that produces tough, sound copper, the upsetting operation should be easy of accomplishment. The inventor describes his process as follows:

"A method of making metallic bands consisting in providing a washer-shaped ring of material thickness, said ring being thinner at its outer diameter than at its inner diameter, upsetting said ring to form a cylindrical band of substantially the same thickness throughout, straightening and rolling the edges of said band and truing and straightening the walls of the band by compressing the band."

A Simple Hand Sand Rammer

By G. W. Childs

In the accompanying illustration are shown detailed views of a simple hand sand rammer, weighing 12 pounds, which we make at our plant for use in our own steel foundry. The same kind of a rammer, of course, could be employed in any gray iron foundry. It will be noted that the rammer consists of two cast steel heads with the body made from ¾-inch standard wrought iron pipe, the ends of which are welded to the shanks of the heads. The total weight of the rammer is 12 pounds.



DETAILED VIEW OF HAND SAND RAMMER

What Proper Routing Did for an Old Foundry

(*Continued from page* 41)

greater efficiency. The first move consisted of the removal of the dusty cleaning operations to the open air, thus ridding the foundry of excessive dust and giving the cleaning gang more fresh air. In conjunction with this move the sand-blast was placed in a remote corner of the yard and wind or dust shields were erected around it.

The efforts of the employer to further satisfy the employes were demonstrated by furnishing a warm noonday lunch at a nominal fee; a slightly lower but more rigid piece-price; the addition of a 10 per cent monthly bonus; encouragement of Y. M. C. A. work and athletic activities at the noon hour; the installation of a steam-heat-

ing plant in place of the old and unhealthful salamander fires and the establishment of a first-class first aid hospital room. The good feeling thus engendered between employe and employer has been found to greatly increase the average efficiency by holding the good workman more steadily at his job.

Vanadium Bronze Contains No Manganese

On page 497 of the November issue of THE FOUNDRY, under the caption entitled "Making Vanadium Bronze", was published a statement to the effect that vanadium bronze is a manganese bronze that has been treated with vanadium. We have been advised by the Vanadium Metals Co., Groton, Conn., that vanadium bronze contains no manganese and, therefore, is not a manganese bronze. Vanadium is used as the deoxidizer instead of manganese.

New Nickel Copper Alloy

A new nickel-copper alloy has been placed on the market by the Electrical Alloy Co., 135 Broadway, New York, as a permanent substitute for German silver. Claiming that the high zinc content in German silver is objectionable because it renders any alloy containing it liable to breakdown even under moderate rises in temperature, the company recommends the use of this alloy for rheostats, car heaters and other apparatus where German silver usually is employed. The former is stated to be non-corrosive and capable of withstanding higher temperatures than German silver. The specific resistance of the new alloy is 290 ohms per mil. foot, and the temperature co-efficient is 0.001 Fahr. This alloy, as well as others which the company produces, is described in a circular recently issued.

Trade Press Announces Consolidation

The International Trade Press, Inc., Chicago, announces the purchase of the Cement Era Publishing Co., of that city. A consolidation will be effected of the *Cement World*, the *Cement Era* and the *International Trade*, to be known as the *Engineering and Cement World*, which will be issued semimonthly. The first consolidated number will appear Jan. 1. The officers of the International Trade Press, Inc., follow: Charles W. Price, chairman of the board of directors; C. A. Tupper, president-treasurer; Lyman A. Sisley, vice president and secretary, and Harry W. Walker, business manager.

"Autographs of Successful Men" is the title of a booklet issued by the Sand Mixing Machine Co., 52 Vanderbilt street, New York, manufacturer of the auto sand cutter. The booklet contains a large number of testimonial letters received from users of the sand cutters built by this company, which testify to their economy and efficiency.

Trade Notes

The Asbestos Protected Metal Co., Pittsburgh, is now represented in the state of Georgia by J. F. Schofield's Sons Co., located at Macon.

Hamilton & Hansell, builders of the Rennerfelt electric arc furnace, have removed to the Park Row building, New York, where larger offices provide increased facilities for their growing business.

A 4-page bulletin has been issued by the Oliver Machinery Co., Grand Rapids, Mich., which briefly illustrates and describes its universal vertical and horizontal woodboring machine especially adapted to pattern shop work.

The American Gum Products Co., New York, announces that it is again extending its large plant at Covington, Va. This is the second addition made to this plant within a year. This company manufactures a dry core binder.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Contractors Machinery Mfg. Co., Los Angeles, will build a foundry.

The Hercules Gas Engine Co., Evansville, Ind., will enlarge its foundry.

G. A. Robinson, Sixth and John streets, Anderson, Ind., has completed a new foundry for making brass and aluminum castings.

The Singer Mfg. Co., South Bend, Ind., will build a 60 x 150-foot foundry addition to cost $15,000.

The Cooley Mfg. Co., Seattle, will build a brass foundry and plans to make other additions to its plant.

The Bernstein Mfg. Co., Third and Allegheny avenues, Philadelphia, will build a large addition to its foundry.

The Independent Stove Co., Owosso, Mich., has awarded the contract for a 4-story, 60 x 100-foot addition to its foundry.

The Defiance Machine Works, Defiance, O., has secured a site for the erection of a foundry.

The Holmes Foundry Co., Sarnia, Ont., Can., will build a plant to cost $75,000, on which work will be started at once.

The Akers Mfg. Co., Kansas City, Mo., has been chartered with $30,000 capital to make brass and iron castings. The incorporators are H. H. Akers, A. A. Buxton and L. A. Buxton.

The Emerson Brantingham Co. will erect a 2-story foundry 40 x 60 feet in size, for which contracts have been awarded.

The Superior Iron Works, Superior, Wis., is building a foundry, 65 x 100 feet, which will double its capacity.

The J. P. Devine Co., 3172 Clinton street, Buffalo, plans to build a 26 x 200-foot foundry addition, to cost $6000.

Anderson & Jackson, 722 Court street, Brooklyn, N. Y., will build a foundry, 52 x 78 feet, to cost $7000.

The Cravier Foundry Co., Rochester, N. Y., has been organized by J. T. Cravier, L. C. Graves and T. Hanlon Jr.

The Pennsylvania Bronze Foundry Co., Seventh and Camp streets, Harrisburg, Pa., will build a 35 x 100-foot foundry.

W. H. Banfield & Sons, 372 Pape avenue, Toronto, Ont., Can., will build a foundry, for which contracts will be awarded shortly.

The Birdsboro Foundry & Machine Co., Newcastle, Pa., will build an addition to its plant.

The International Engineering Co., Amherst, N. S., Can., will build an addition to its foundry on Laplante street. The cost is estimated at $5000.

The Lynchburg Foundry Co., Lynchburg, Va., contemplates building a foundry to cost $60,000.

The Acme Brass Foundry Co., Pittsburgh, has been incorporated with $25,000 capital H. I. Wasserman is treasurer of the company.

McCord & Co., Chicago, will build a foundry at 847 120th street. The structure will cost about $30,000.

The Pollak Steel Co., Carthage, O., will build a 200 x 300-foot addition to its foundry, for which contracts have been awarded.

The Madison Foundry Co., 939 Addison road, Cleveland, has awarded contracts for an addition to its plant.

The Patterson-McDonald Shipbuilding Co., Seattle, will build a plant, to include a large foundry.

George A. Leighton, Manchester, N. H., will build a 58 x 80-foot addition to his foundry, to cost about $8000.

The Reeves-Cubberly Foundry Co., Parker and Logan avenues, Trenton, N. J., will build additions to its plant.

The Mahoning Foundry & Machine Co., Punxsutawney, Pa., has been organized by V.

A. Gillespie. The company has a capital of $30,000.

The Lewis Foundry & Machine Co., Groveton, Pa., has increased its capital from $210,000 to $1,000,000 to provide for plant additions.

M. A. and L. J. Garvey, Sharon, Pa., have obtained a site from the board of trade, Warren, O., on which they will build a brass foundry.

The Wisconsin Foundry & Machine Co., 623 East Main street, Madison, Wis., will build an addition to its plant.

The Gunning Boiler & Machine Co., 67 South Water street, New Bedford, Mass., has awarded contracts for a 4-story addition, 36 x 134 feet, to its foundry and machine shop.

The H. & H. Foundry Co. has been incorporated with $15,000 capital. The incorporators include Benjamin Harris, John Hanson, C. Pond Webb and Nicholas Rominello.

The Jahant Foundry & Heating Co., Akron, O., has been incorporated with a capital of $100,000. The incorporators include H. F. McGill, Philip B. Treash and A. H. Comming.

The Corning Foundry Co., Corning, N. Y., has been incorporated with $100,000 capital by W. M. Gurnsey, S. E. Flitner and B. W. Wellington.

P. J. Driscoll, Reading, Pa., has purchased a site at Hamburg, Pa., on which he plans to build a foundry for making electric steel castings.

Extensive repairs will be made to the brass foundry of the L. R. Halsted estate, 1129 Cherry street, Philadelphia, which was recently damaged by fire.

The Columbia Bronze Foundry Co., Camden, N. J., has increased its capital from $10,000 to $100,000 to provide for extensions to its plant at 529 Columbia avenue.

The Davis Foundry Co., Newcastle, Ind., has been incorporated with $40,000 capital to erect a foundry. John G. Hey, Louis B. Patterson and William Davis are interested.

The National Malleable Castings Co., Cleveland, will build a steel and concrete welfare building to cost $60,000, at 10600 Quincy avenue.

The Victor Trailer Mfg. Co. has purchased the plant of the Nebraska Foundry Co., Omaha, Neb., which will be enlarged and improved.

The Valveless Pump & Foundry Co., Portland, Oreg., has leased the plant formerly occupied by the Portland Stove Works, and will equip a foundry and machine shop.

The Alloy Foundry & Machine Co., New Rochelle, N. J., has been incorporated by A. C. Wakeling, W. E. Wollheim, 2467 Valentine avenue, and others. The company is capitalized at $10,000.

The Durbin Automatic Train Connector Co. East St. Louis, Ill., will build a 1-story foundry. V. S. Durbin, Pontia building, St. Louis, is president of the newly organized company.

The Hercules Electric Steel Corp., New York, has been granted a charter. The incorporators are W. L. Scott and W. H. Rich, 110 Liberty street. The company is capitalized at $50,000.

The Atlantic Refining Co., Harrisburg, Pa., has purchased the plant of the Pennsylvania Bronze Foundry Co., Camp and Seventh streets, and will build a foundry at Camp and Emerald streets.

The Cambridge Foundry & Machine Co., Cambridge, O., has been chartered with a capital of $50,000. The incorporators are Mark A. Copeland, F. B. Everts and C. M. Verby.

The Renfrew Refrigerator Co., Renfrew, Ont., Can., has been incorporated with $100,000 capital and will engage in a foundry and machine shop business. The following are directors: Robert Handley, Alexander Blue and Samuel Moffatt.

The Alloy Steel Works, Ltd., Toronto, Ont., Can., will take over the plant of the Moffatt Irving Steel Co. The new company plans to make a number of plant additions and to install a furnace for making electric steel castings.

The Beckemeyer Foundry Co., Beckemeyer, Mo., has erected a small jobbing gray iron foundry and will specialize in mine cars and wheel work. H. H. Timmerman is secretary and general manager, and E. T. Williams is foundry superintendent.

The Kansas City Malleable Foundry, Kansas City, Kans., which has been idle since 1916, has been taken over by the Thomas Railway Track Appliance Co., which is manufacturing a patent malleable railroad tie plate. About 50 men are employed.

The St. Louis Car Co., St. Louis, manufacturer of trolley cars, has erected a small malleable iron foundry employing 12 men, the product of which is used by this plant. Edward B. Meissner, assistant to the president, is in charge of the foundry.

The Falk Co., Milwaukee, has received a large government contract for herringbone gears, which necessitates the building of an addition to its foundry. Contracts have been awarded, calling for a brick and steel building, 175 x 350 feet, to be finished within 90 days.

The United States Gear Shift Co., Eau Claire, Wis., will build a plant to include brass and aluminum foundries. The company has been recently organized to manufacture gear shifting devices under the patent of L. A. Laursen, its general manager. The concern is capitalized at $1,500,000.

The Glenrock Foundry & Machine Co., Glenrock, Wyo., has been incorporated with $100,000 capital and will engage in the manufacture of castings and machinery. Stuart Anderson is the president of the new company, which has already secured a site for its proposed plant.

The Whitman Agricultural Co., St. Louis, manufacturer of hay tools and mill supplies, will change its firm name to the Whitman-Bull Tractor Co., following a combination with the Bull Tractor Co., Minneapolis. The equipment of the latter company's plant will be removed to St. Louis and a new foundry will be erected in the spring that will have a capacity of about 15 tons daily.

The Fulflo Pump Co., Cincinnati, is erecting a 2-story machine shop and foundry on a site of five acres at Blanchester, O., on the main line of the Baltimore & Ohio railroad. On March 1 the output of the plant will be approximately 500 small centrifugal pumps per day and by July 1 it is expected that the capacity will be doubled. The plant is equipped to manufacture pumps made of cast iron, brass, bronze and aluminum.

The Queen City Foundry Co., Toronto, Ont., Can., has been taken over by the Bond Foundry & Machine Co., Manheim, Pa., which will operate the plant under the name of the Bond Engineering Works, Ltd. The new owners will make a number of additions to the plant and will install equipment for the manufacture of transmission machinery as well as gray iron castings.

The Liberty Foundry Co., Milwaukee, has been organized to engage in the manufacture of light gray iron castings. A plant now is being built and the equipment is being purchased. G. W. Mockly, president, for 11 years was treasurer and manager of the Wisconsin Foundry Co., Milwaukee, and Edward G. Mockly, who will be in charge of operations, formerly was superintendent of the Wisconsin Foundry Co. W. J. Buckley, who has been elected secretary and treasurer, occupied the same position for 14 years in the T. L. Smith Co., Milwaukee.

New Trade Publications

PRESSURE PUMPS. — Pot valve pressure pumps are illustrated and described in a 48-page catalog issued by the Worthington Pump & Machinery Corp., New York. Pumps of various sizes and types are illustrated and tables of sizes and capacities are included.

DUPLEX PISTON PATTERN PUMPS.—The Worthington Pump & Machinery Corp., New York, has issued a 52-page catalog devoted to Worthington duplex piston pattern pumps for general service. These are employed for all purposes where the water pressure is 150 pounds per square inch or less and where a direct acting steam pump is the proper installation.

CLEANING ROOM EQUIPMENT.—A 20-page bulletin has been issued by the Whiting Foundry Equipment Co., Harvey, Ill., which is devoted to its extensive line of tumbling barrels and dust arresters. Numerous views are included showing installations of this cleaning room equipment and various types of machines also are shown, such as round steel plate barrels, square barrels, cast iron stave barrels, tumblers for brass work, as well as water cinder mills.

ADJUSTABLE SPEED MOTORS.—An 8-page bulletin, issued by the General Electric Co., Schenectady, N. Y., illustrates and describes its line of adjustable speed motors. Commutation troubles arising from abuse or careless operation have almost entirely been eliminated and the main field coils are designed so as to withstand, without injury, full potential continuously with the armature at rest. The various parts of this machine are described in detail and a table of dimensions also is included.

THERMIT CARBON-FREE METALS.—A 32-page pamphlet has been issued by the Goldschmidt Thermit Co., New York, which is devoted to its extensive line of carbon-free metals consisting of chromium, ferrochromium, manganese, cobalt, ferrotitanium, ferrovanadium, tungsten powder, ferrotungsten, manganese copper, phosphor copper, manganese titanium, manganese boron, silicon copper, chromium copper, cobalt copper, nickel copper, vanadium copper, titanium copper, manganese aluminum, ferrosilicon and ferrophosphorus. A section of this pamphlet outlines the use of heating thermit cans for increasing the temperature of iron and steel, for making semi-steel in the ladle, the use of thermit in risers, etc.

FOUNDRY MELTING EQUIPMENT.—Three catalogs have been issued by the Whiting Foundry Equipment Co., Harvey, Ill., devoted respectively to cupolas, brass melting furnaces and side-blow converters. The cupola catalog supersedes a catalog previously issued and illustrates and describes in detail the Whiting cupola. A small test cupola, 27 inches in diameter, is shown, as well as bottom door hoists, blast gages, cupolas for continuous service, cupola charging machine, charging cars, etc. Brass melting furnaces and accessories are illustrated and described in an 8-page pamphlet which also shows a large number of installation views. The steel converter designed by the Whiting Foundry Equipment Co., is illustrated in a 16-page pamphlet which contains a large number of installation views. The ground plan of a model converter steel foundry also is included.